Understanding New Zealand's changing vehicle travel patterns

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Richard Cameron Sheild

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In recent years New Zealand has seen a changing trend in its vehicle kilometres travelled (VKT) per capita, which has generally trended downward. This is part of a global trend occuring across a number of western countries, but explanations for this trend remain contentious. There is very little research examining New Zealand's VKT per capita trend, or seeking to explain it.

This research will use multiple linear regressions to examine how New Zealand's VKT per capita trend compares to a variety of economic, spatial, and social trends that have been identified in the literature as having possible explanatory power.

This research found that in New Zealand's case, economic indicators were most closely correlated with VKT per capita trends, especially the unemployment rate and retail price for petrol. However, given the short timeframe that the data could represent these conclusions must be treated with a degree of caution. More research may be useful to further vaildate this project's findings.

Keywords: transport, planning, travel behaviour, VKT, GDP

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Chapter 1

Introduction

The concept of 'peak car' embodies the idea that car use has reached its maximum in some parts of the world and is now beginning to decrease. One means of measuring vehicle use is 'vehicle kilometres travelled per capita', otherwise known as 'VKT per capita'. In much of the developed world, VKT per capita has begun to plateau and decrease over the past fifteen years (BITRE, 2012). New Zealand is no exception to this trend, with VKT per capita plateauing around 2003 and beginning to decrease around 2006 (BITRE, 2012; Ministry of Transport, 2017a; Ministry of Transport, 2017b). Since 2011, there has been a slight increase in VKT per capita, however it still remains lower than the high observed in 2006. The reasons for this are uncertain, and disputes continue. A wide variety of possible explanations have been offered, covering economic factors (changes in GDP per capita), spatial factors (city density), and social factors (lower proportions of young people driving). There has been no conclusion drawn to explain this trend in New Zealand. This is surprising when one considers the significant ramifications of this trend and understanding what causes it (more on this below). Consequently, this research is aiming to help fill this gap in existing knowledge by exploring and analysing possible explanations for the VKT per capita trends currently taking place in New Zealand.

1.1 Why is this research important?

Understanding the causes of VKT decrease would be of value to policy makers and planners for a number of reasons. As virtually all vehicles in New Zealand are powered by fossil fuels, a decrease in VKT per capita leads to a decrease in greenhouse gas emissions from the transport sector. Furthermore, the New Zealand government has committed itself to reducing greenhouse gases, and reducing emissions from transport will likely be a key component of this push. Researchers have already identified decreasing VKT per capita as a means of reducing greenhouse gas emissions from a country's transport sector (Nishimura, 2011; Huo et al, 2012). This is of use to both policymakers and planners.

For policymakers, understanding what has caused this small decrease in VKT per capita is important as this will provide guidance on how to further decrease this figure (and resulting carbon emissions). This would allow for more targeted and effective public policy, as well as more detailed knowledge of costs associated with such policies when compared to benefits.

The findings are also potential important for planners, who need this understanding in order to best cater for transport in cities. If the causes of the decrease can be controlled to a degree by policy or planning, then further decreases in VKT per capita can be encouraged.

As noted earlier, this research intends to contribute to understanding the reasons behind this decrease in VKT per capita. This research will focus on a variety of quantifiable indicators identified in the literature review, selecting 2-3 indicators for each of the subcategories identified below. The majority opinion in the literature is that economic factors are the most accurate explanations or the most significant contributors to VKT per capita trends (Bastian & Borjesson, 2015; Bastian et al, 2016; BITRE, 2012). This suggests that such economic factors may also be an explanation for New Zealand's VKT per capita trends. With that said, there is also the possibility that New Zealand could have a different context to the countries studied in the literature thus far. With that in mind, this research will consider a wider array of factors and indicators.

Chapter 2

Literature Review

The following literature review will show that there is relatively little published academic literature concerning the causes of the global plateauing and decrease of VKT or VKT per capita. Nonetheless, there is still enough to allow several key themes or explanations to be drawn out. There are also clear debates within the literature, with specific causes of the VKT per capita trends currently being disputed by several scholars.

This section will outline three important subsets of literature. Two of these are broad themes or causes identified by Curran (2014); economic factors and social trends. However, these two categories do not adequately cover all possible explanations, and I believe a third grouping or theme needs to be added: spatial trends.

The subsets represent different themes or explanations for decreasing VKT per capita trends. The first of these explores social explanations for this trend, such as changes in behaviour among young people and the rise of social media. The second focuses on spatial trends, and the increasing density of urban area. The third and final theme consists of economic trends, such as fuel prices and gross domestic product.

2.1 Social trends

The explanation that appears to have the most literature supporting it is that of social factors. Among the earliest research to offer social factors as an explanation is Newman and Kenworthy's 2011 article. They posit that as cities become older (in terms of the average age of the population), then vehicle travel per capita will decrease, as older people tend to travel less (Newman & Kenworthy, 2011). Additionally, the authors also offer the idea of a "culture of urbanism", whereby people choose to move back into cities from suburbs for the opportunities these cities provide (Newman & Kenworthy, 2011).

In an article focusing on Germany in particular, Kuhnimhof et al (2012) make use of German household travel surveys and income/expenditure surveys to determine travel demand by age group, and how this has changed over the past four decades. The authors note that in the fifteen years prior to the article being published, car ownership and percentage of people with licences declined among young people, young men especially. They argue that this decline, along with growing use of other modes of transport by car owners accounts for the changes in Germany's VKT.

A similar study was conducted that same year, this time using data from six countries. Again, Kuhnimhof, Zumkeller, & Chlond (2012) made use of household travel surveys from these countries (Germany, Great Britain, France, Norway, Japan, and the United States) to determine trends in car ownership, modal split, and licence acquisition. Again, the study concludes that the change in behaviour amongst young people, especially men, is what has led to this decrease in VKT across six quite different industrialised nations (Kuhnimhof, Zumkeller, & Chlond, 2012). In particular, the increasing demand for tertiary education and the more limited means this forces upon students is identified as a probable key driver of the trend.

In contrast to Kuhnimhof's work focusing on several different nations, there is also some research published focusing on social trends in a single country. Puentes (2012) is one such scholar, whose work focuses on the American context. He notes that despite the United States' rapid population growth, the number of licenced drivers in the country is nearly static. Puentes (2012) attributes this shift to changes at the young and old extremes of population age; younger people are shying away from driving while older drivers are also driving less for medical reasons, such as arthritis or vision degeneration. The article also delves into historic reasons for the increase in VKT per capita that has been seen over the past several decades and why these will not continue into the future. For example, Puentes (2012) cites the huge number of women entering the workforce over the past half-century as being a significant cause of the increase in VKT per capita in the United States, a driving factor that simply cannot be repeated.

Further analysis of social trends is provided by Kuhnimhof et al (2013). As with other studies led by Kuhnimof, this article uses household travel surveys as the source of its data, but does something different with it compared with the two previous pieces. The data is used to create a mathematical model that outputs what the authors' call CKM, or car kilometre travelled per person – equivalent to VKT per capita (Kuhnimhof et al, 2013). They conclude that the aging of urban populations has helped contribute to the decline in VKT in the case study countries, along with changing demand for travel, which is argued to have decreased to varying degrees over the previous quarter century.

Metz (2013) reaches a similar conclusion to Kuhnimhof's studies. He also argues that the reduction in VKT in the United Kingdom is driven by young people (especially men) turning away from owning or driving vehicles and making greater use of varied transport modes (Metz, 2013). Metz also argues that modal shift plays a role in this trend, especially in London, where much business travel in particular has shifted from cars to trains. However, Metz does not support his claims with hard data to the extent that Kuhnimhof's various studies do; indeed, it is sometimes difficult to determine the basis for some of Metz's assertions, as they go unsupported.

Norway has also exhibited similar trends. Hjorthol (2016) examined Norwegian travel surveys to determine the rate of licence acquisition among young adults. The figures showed a decrease throughout the 1990s and stagnation since the turn of the millennium. Hjorthol identifies several possible explanations for this decrease in licence acquisition and car use. One is societal change. As time has gone on it has become common in Norway to delay having children and getting married, meaning there is simply less demand for independent travel. A rural-urban divide also exists here; Hjorthol (2016) notes that licence acquisition and driving behaviour more generally has changed very little in rural areas of Norway. The changes have been driven by urban areas, where many young people tend to be students and rely on public transport.

The rise of social media, online shopping, and other ICT-based activities is another reason sometimes offered for the changing patterns in VKT per capita. One scholar to explore this aspect is Van Wee (2015), who examines the role such ICT-based activities may play in the decreasing VKT per capita currently seen. The crux of this argument is that younger people (those who grew up with digital technology) are most comfortable substituting activities with ICT-based equivalents than even those who were relatively young when such technology become commonplace. However, Van Wee (2015) cautions against assuming that this shift is solely responsible for the decrease in VKT per capita. For instance, he notes that not all activities can be substituted with IT-based equivalents and that there is thus a limit to which the shift to ICT-based activities can reduce car travel.

Goodwin (2012) makes a similar argument. He notes that virtually all functions of a car (for instance, socialising) can be replaced by computing technology, especially smartphones. Goodwin then delves further into cultural or sociological aspects than Van Wee does, noting that smartphones can not only replace cars functionally but also as a status symbol for younger people in the way cars were for previous generations. This is speculation however; Goodwin (2012) notes that there had been virtually no scholarship or government funded research on the role smartphones might play in these shifts in travel behaviour at the time the research was published. This does not seem to have changed much subsequently either.

Several of these trends are noted in the New Zealand context by McSaveney and Sage (2014), who note that New Zealand is becoming a more urbanised nation as time goes on. In particular, the growth of Auckland and the alternative modes of transport to private vehicles the city offers is a factor that could impact on VKT. They also note that drivers licence attainment rates have decreased over time, but state that this may be partly attributable to the government raising the minimum age to be eligible. McSaveney and Sage's generally shies away from establishing correlations and causation, instead demonstrating a series of trends that may relate to VKT in New Zealand.

2.2 Spatial trends

Newman and Kenworthy (2011) provide an overview of possible spatial reasons for the decline in VKT in the western world. They note that between 1960 and 2005 data showed that many large cities in the west were filling in faster than they were growing out as population density increased (Newman & Kenworthy, 2011). They argue that this represents a new trend in western cities, which have for decades expanded outwards and become less dense as the automobile allowed for such lifestyles. Importantly, Newman and Kenworthy claim that this increasing densification is not attributable purely to population growth in a finite area, but also to a reversal of the suburbanisation and urban sprawl trend, as people increasingly want to live in cities (Newman & Kenworthy, 2011). More location specific analyses are provided by other scholars.

One example of such an analysis is provided by Metz (2015) in an article focussing on London in the United Kingdom. Metz notes that London has very little in the way of greenfield sites it can use to develop but has extensive brownfield sites. This, combined with minimal spending on roads compared to public transport and active transport infrastructure, has resulted in declines in car trips and travel over the past several years (Metz, 2015). This increasing density is linked to modal shift in Metz's argument, as he considers cars to be less useful in cities such as London compared to public transport or cycling; ergo, increasing density leads directly to lower vehicle use and thus lower VKT (Metz, 2015).

Another analysis of spatial trends on VKT per capita in England is provided by Headicar (2013). The articles notes that VKT per capita has decreased in virtually all kinds of urban areas in England over the past 30 years, ranging from huge cities down to smaller towns and villages. Headicar (2013) attributes the decreases in VKT per capita to policies emphasising higher density residential development and greater use of brownfield development in disused industrial areas. Headicar (2013) also incorporates population growth into the analysis. This suggests that policy changes can be effective in encouraging denser development and thus lower VKT per capita.

2.3 Economic trends

As with the previous two themes, Newman and Kenworthy (2011) provide something of a summary of some economic dimensions: in this case, fuel prices. They note that the relationship between fuel prices and car use has been known since the fuel crisis of the 1970s, which exposed the reliance of a suburban automobile dependent lifestyle on cheap petrol. The authors also emphasise fuel prices as the cause of the global financial crisis of the late 2000s, arguing that high fuel prices left sub-prime mortgagees unable to pay their mortgages and thus led to the subsequent housing and financial crises (Newman & Kenworthy, 2011). The rationale here is that when fuel is expensive it compromises either the ability to travel or to pay for expenditures other than fuel. It is not the higher prices that decrease VKT per se, but rather the flow on effects, such as having to devote more income to paying for fuel, leaving less for 'luxury' activities, such as recreational travel or shopping.

A comprehensive research report published on the role of economic factors has been produced by Australia's Bureau of Infrastructure, Transport, and Regional Economics (BITRE). The organisation has published a detailed and technical report that demonstrates VKT per capita figures in developed countries have been remarkably similar; showing growth throughout the second half of the 20th century, then plateauing or decreasing throughout the 2000s (BITRE, 2012). The report concludes that fluctuations in petrol prices and the impact of the global financial crisis are effective explanations for the trends in VKT per capita that have been recorded (BITRE, 2012). In addition to these two key economic factors, the document also emphasised the role that saturation (the demand for capacity as a proportion of total capacity) plays in the VKT trends. However, it appears that the aforementioned economic factors have the strongest explanatory power.

Some of the most vocal proponents of economic explanations for VKT trends are Bastian & Borjesson (2015), who have published work focussing on Sweden. Their work makes extensive use of modelling; using an OLS (ordinary least squares) model to attempt to establish relationships between Swedish VKT per capita trends, fuel prices, and GDP per capita. The research concludes that much of the VKT per capita trend in Sweden can be explained by the trends in economic factors, namely fuel prices and GDP per capita (Bastian & Borjesson, 2015). However, the authors stop short of saying that these economic trends account for all the changes in Sweden's VKT per capita; this indicates that the causes of VKT trends may possibly be more complex.

Bastian et al (2016) reach a similar conclusion in another article that considers multiple industrialised nations. Again, the research is based upon a quantitative model, in this case a constant-elasticity model. Again, the factors considered are VKT per capita, fuel price, and GDP per capita. The authors conclude that while the model is simple, it is nonetheless able to use fuel prices and GDP per capita to accurately predict VKT per capita across an array of developed nations (Bastian et al, 2016). The model is not perfect however; it failed to accurately predict the decrease in VKT per capita in Australia, where the decrease was larger than the model predicted.

However, not all scholars agree that economic trends can explain VKT per capita trends. For instance, Kenworthy (2013) argues that GDP growth has become "decoupled" from VKT growth. Kenworthy's analysis examines several dozen cities across four continents, and tracks changes in VKT per unit of GDP. The analysis demonstrates that in many cities VKT has indeed become decoupled from GDP, with GDP continuing to grow while VKT stays fairly static. This results in what is often a significant decrease in VKT per unit of GDP; in Madrid for instance, the VKT per unit of GDP more than halved between 1995 and 2005 (Kenworthy, 2013). This seems to indicate that in many large cities, GDP does not correlate with VKT.

A similar somewhat mixed conclusion was reached by Van Dender & Clever (2013). Their research is of particular relevance as it uses a regression analysis to determine relationships between PKM (passenger-kilometres) and economic variables such as fuel prices and GDP. The research compares trends in half a dozen countries over the past four decades. Perhaps the key conclusion is that the focus on just economic factors such as those discussed or named above is too crude to cover the wide variety of possible factors that could influence vehicle travel. The authors themselves express this view (Van Dender & Clever, 2013). This is not to say the modelling did not show a relationship. It did, however the relationship was dismissed by the authors as not being strong enough to conclude that economic factors alone are responsible for the changing trends.

Goodwin & Van Dender (2013) offer a mixed and more nuanced analysis of the reasons for the decrease in VKT per capita. Their article examines the findings of several other studies and draws two key conclusions. The first is that economic factors are still important and play a role in the changing patterns in vehicle use. However, the authors note that elasticities (the sensitivity of these factors to changes in other factors) are decreasing with regard to economic factors and that these factors are no longer as strongly correlated with travel behaviour as they once were (Goodwin & Van Dender, 2013). Like many other scholars, they posit that social change is becoming the driving factor in these changing trends and is becoming more significant in determining these patterns than it previously has been. This could indicate an extremely complex picture in which different kinds of variables are more important at differing times.

2.4 Research question

This research attempts to answer the following question:

"What factors are most likely to be responsible for the decline in per capita vehicle kilometres travelled in New Zealand?"

There has been very little academic research published thus far in New Zealand concerning VKT and its relationship with economic, social, and spatial trends. This research aims to establish whether or not there is a correlation between these data trends. It is important to note at the point that this research will not aim to establish causation – that is beyond the scope of this research. However, if a correlation is established, this provides a foundation for future research on the relationship between VKT and various indicators. Conversely, if this research is unable to establish such a correlation, this may suggest that other factors influence New Zealand's changing VKT trends.

2.5 Summary

VKT per capita in New Zealand is under-researched in general, and academic examinations into why it has shown this trend of plateauing and decreasing are rarer still. This leaves a number of possible directions research into VKT per capita trends in New Zealand could take.

Chapter 3

Methodology

This research used a desk-based, quantitative methodology. A multivariate Linear Regression method was used to identify the statistical significance of independent variables (such as GDP and employment) in explaining the observed trend in VKT per capita. Data was analysed using a software program called SPSS.

3.1 The variables

This research tested VKT per capita against a variety of economic, social, and spatial indicators. The data used an annual timescale to allow for straightforward comparison and analysis. The timeframe used was 2000-2015, this being the timeframe for which VKT per capita data is available. In some instances, the data for the variables does not cover this full fifteen-year period; where this occurred it was noted as a limitation to any findings.

Three distinct economic indicators are used as variables in this research: Gross Domestic Product per capita, petrol prices, and unemployment rate. The rationale for comparing gross domestic product to VKT per capita is fairly simple; as GDP per capita increases, so should VKT per capita. Higher GDP per capita would tend to suggest a healthier economy that provides more reasons for travel, be they for shopping, commuting to and from work, or recreation. The retail petrol price may also interact with VKT per capita, as higher petrol prices may cause a reduction in car travel and thus a reduction in VKT per capita. Finally, a lower unemployment rate may correlate with higher VKT per capita, as this would mean more people have jobs to travel to and from, as well as more disposable income.

There are several possible spatial indicators this research could have used: house prices and size, the number of resource consents for subdivisions granted, and the amount of land rezoned for subdivision are all examples. The difficulty is that data for any of these did not appear to be publicly available, so reliable comparison of spatial variables against VKT per capita is outside the scope of this research. The only way to incorporate some analysis of spatial variables in this research was to make use of proxy indicators. For the purposes of this research, the proxy used is the number of building consents granted annually. The rationale is that higher numbers of building consents granted indicates more greenfield development, increasing travel distance and thus VKT per capita.

Finally, this research will also examine a couple of social indicators. As demand for tertiary education has been identified by the literature as a probable cause for declining VKT per capita, this research will also consider this as an indicator. Another identified social factor is the decline in vehicle ownership and licence acquisition by young people, men in particular. Thus, this research also intends to analyse trends in licence acquisition amongst young people in New Zealand. Finally, this research will also consider trends in air travel, and the potential impacts of a shift to air travel for longer journeys within New Zealand. I have been unable to find data on the average distance travelled by air per capita or air passenger numbers, so I have had to use a proxy. For this research I have selected aviation emissions, expressed as kilotons of CO^2 equivalent emitted annually. A deeper explanation of the rationale behind this is provided further below.

The reason that this research has elected to use per capita data when available is to ensure that population growth is accounted for. For instance, it is expected that VKT in particular as well as GDP would increase as population increases, so using per capita data is a means to removing population growth as a variable. Additionally, having the variables all expressed in proportion to population makes comparison and analysis considerably more straightforward.

Each of the indicators will be analysed against VKT per capita individually using SPSS. The rationale is that this ought to show how strongly correlated each of these factors is to VKT per capita. This made it possible to determine which (if any) of the factors identified has a sufficiently strong correlation to VKT per capita to warrant further investigation.

3.2 Sources of data

First, this research required VKT per capita data. The data used is provided by the Ministry of Transport (2017c), which shows the trend in VKT per capita from 2001 to 2015. The data shows that VKT per capita has remained relatively constant throughout this time period, ranging between 9,000 and 10,000 kilometres travelled per person. However, there have nonetheless been increases and decreases throughout this time period, and the trend is not one of net growth. The data shows that VKT per capita peaked in 2004, and thereafter began a slow decline that lasted until 2013, when it began to increase again (Ministry of Transport, 2017c). This poses some interesting questions, as the temporality of the decease is wider than the changes in other indicators linked with the global recession of the late 2000's.

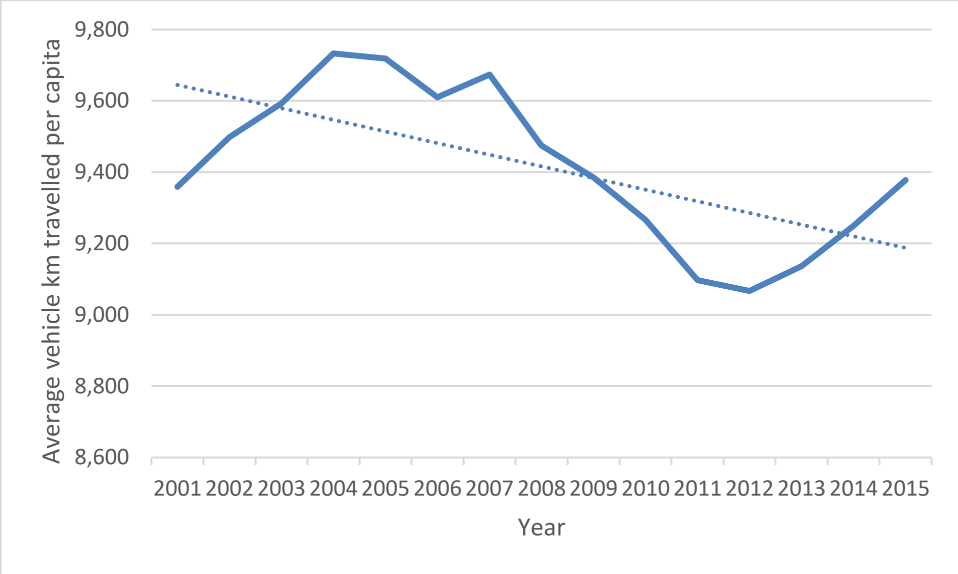

Figure 1: VKT per capita

The data for GDP per capita has been sourced from the World Bank, which maintains a large library of easily accessible and interpretable data. As shown by the figure below, over the decade and a half this research covers the real GDP per capita of New Zealand increased significantly, more than doubling. While the general trend has been an increase, there have been exceptions, most notably during the global financial crisis of the late 2000s. While this decrease can be easily explained, the decrease at the end of the data series is more difficult to explain, and I am unsure as to what caused the said decrease.

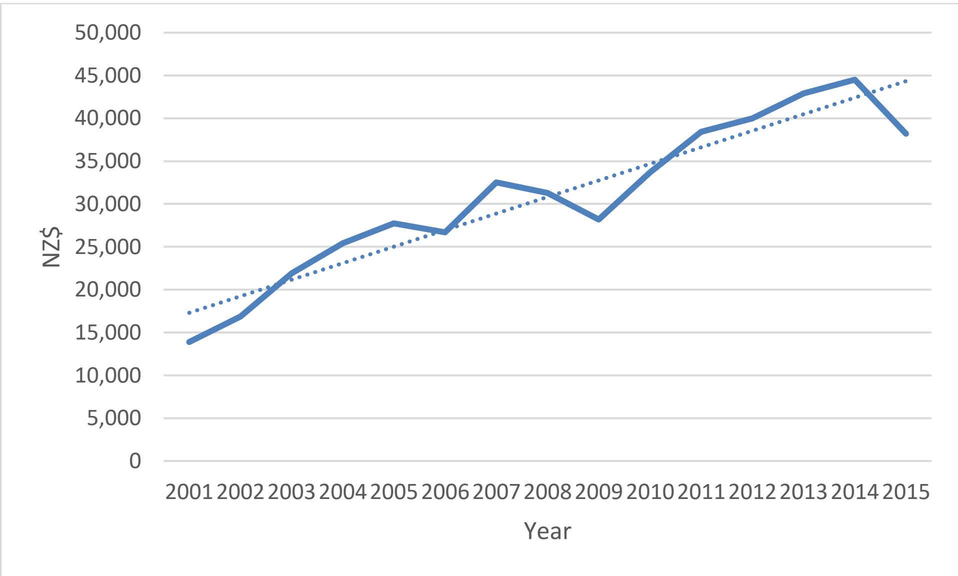

Figure 2: Real GDP per capita in New Zealand

The figure below shows the unemployment rate. Again, this data was retrieved from the World Bank. The trend here has been an increase in the unemployment rate between 2000 and 2015 (World Bank, 2017). Throughout this time period we can see that the unemployment rate was decreasing until around the time of the global financial crisis in the late 2000s, when the rate sharply increased. More recently the unemployment rate has been slowly trending down. This trend also indicates a possible correlation with the GDP; when GDP decreases, unemployment increases.

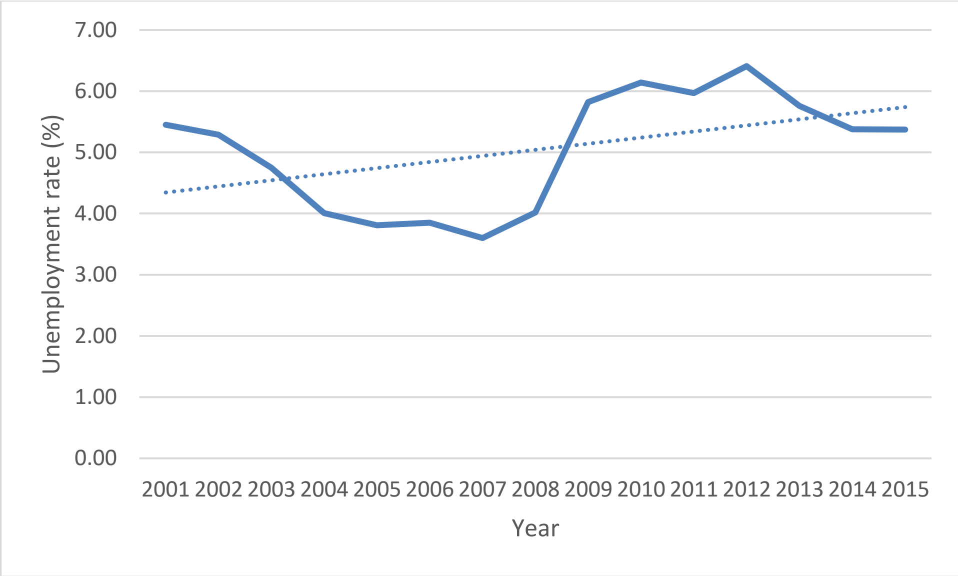

Figure 3: Unemployment rate in New Zealand

The most detailed information on retail petrol prices available is provided by the Ministry for Business, Innovation, and Employment (MBIE), which publishes weekly real petrol price updates going back to 2004. As shown by the figure below, real retail petrol prices have generally been increasing over the time period for which data exists, while remaining stable more recently. One point to note is the decrease around the time of the global financial crisis, likely attributable to lowered demand.

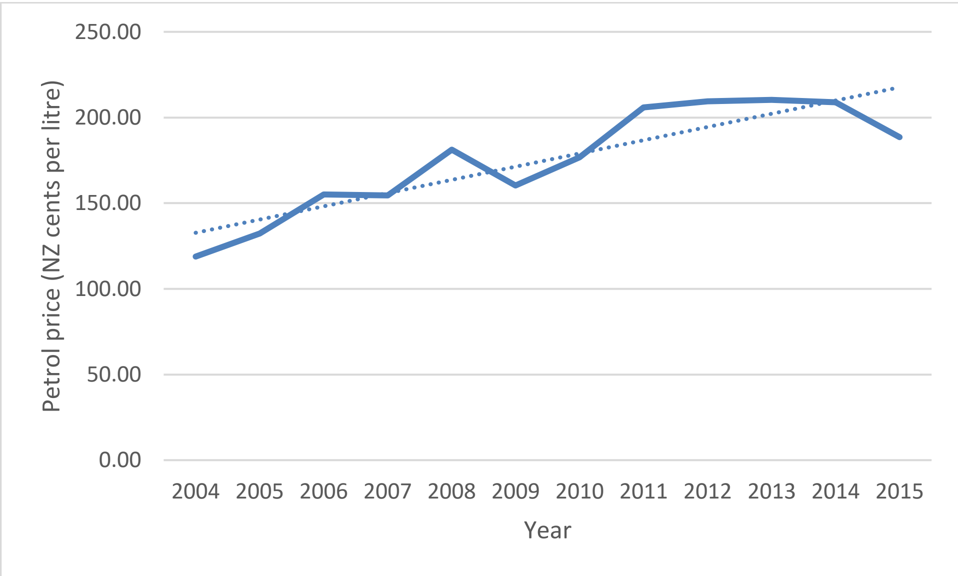

Figure 4: Average petrol retail price

The data for the number of building consents (residential and non-residential) granted annually was retrieved from Statistics New Zealand's archives. As can be seen in Figure 5, the number of building consents granted has been trending down, with an increase in the early 2000s offset by a significant decrease during the late 2000s global financial crisis. During this time, the number of building consents granted halved. As the global economy has recovered, the number of building consents granted has increased again, but in 2015 had yet to reach the pre-crisis high from 2004.

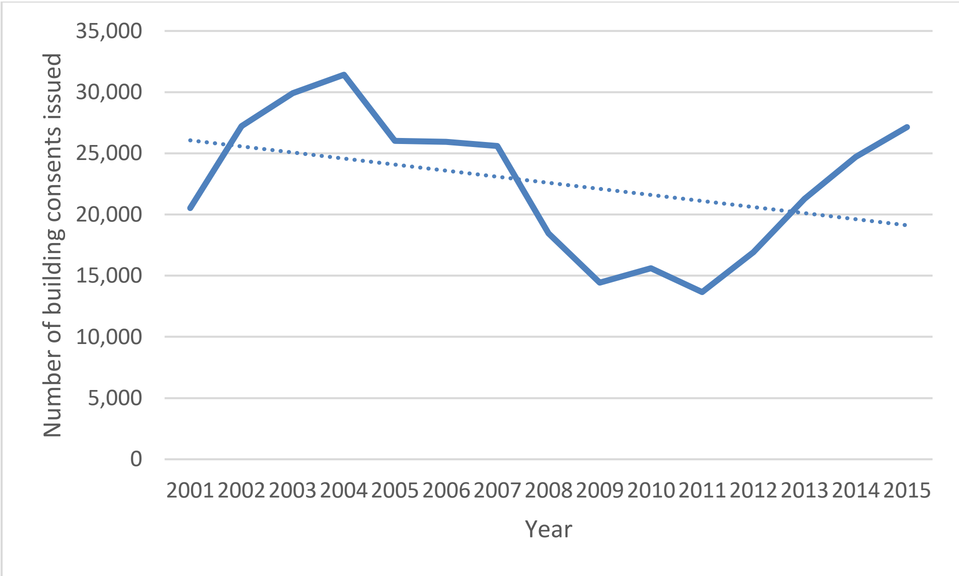

Figure 5: Building consents granted annually

As the figure below shows, tertiary education enrolment rates have been slowly and consistently decreasing over the previous decade. The difficulty with this data is that it covers less than the fifteen-year period covered by most of the other data, making establishing a solid correlation that little bit more difficult. This data, provided by the Ministry of Education, is interesting on another regard, in that it plateaus during the global financial crisis of the late 2000s. This may be attributable to more people choosing tertiary study as an alternative to seeking work in a struggling economy. The reasons for the broader decline are unclear, however.

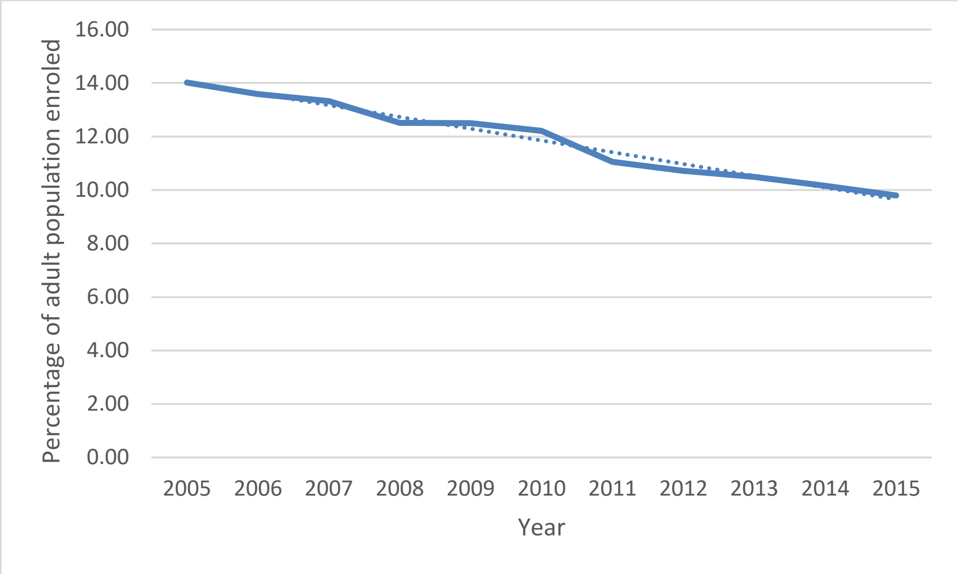

Figure 6: Tertiary education enrolment rate

Statistics obtained from the Ministry of Transport provided the data for the trend in the population of young people with driver's licences. As shown in the figure below, this proportion has been steadily declining over the data timeframe, with a significant decrease in the early 2010s. What is especially interesting about this data is that it does not align with the tertiary enrolment trends; if the literature was applicable to New Zealand, we would expect to see an increase in driver's licences among young people as they turned away from tertiary education. This was identified by some scholars as a causal link. However there does not appear to be evidence of this trend in New Zealand, though this may be attributable to an increase in non-student migrants or an aging population.

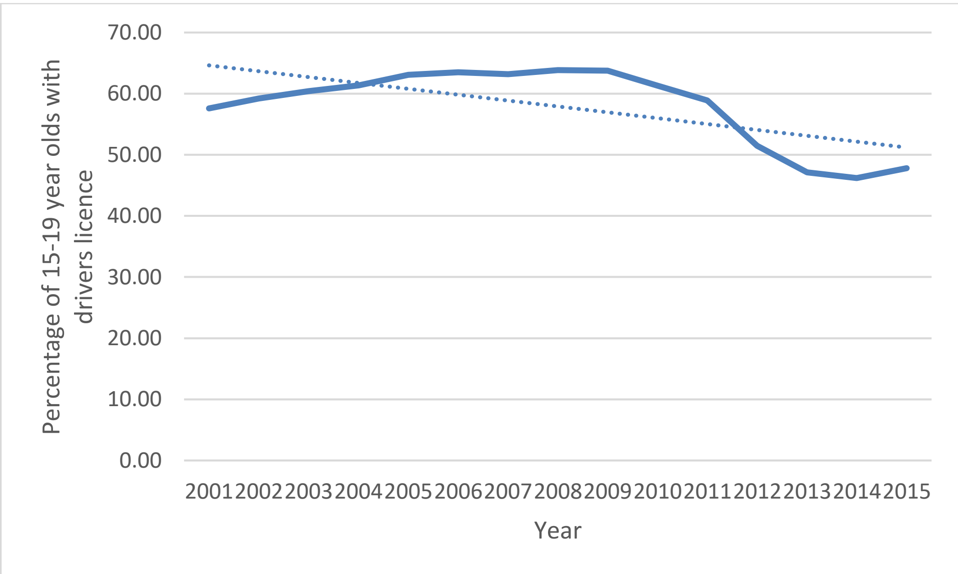

Figure 7: Drivers licence attainment

The data for the trend in CO^2 emissions from the aviation sector was obtained from the Ministry of Transport. The trend shows a gradual decrease in CO^2 emissions form the sector, but it should be noted that this does not necessarily indicate less air travel; instead it is more likely to suggest that New Zealand's domestic air fleet has grown more fuel efficient over this time.

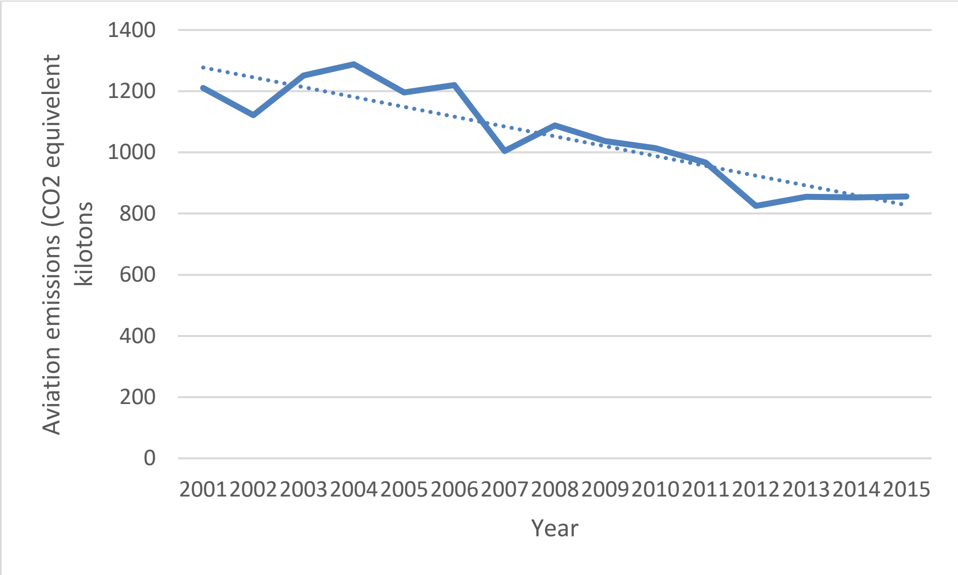

Figure 8: Aviation emissions

3.3 Limitations

There are some limitations to this method that are attributable to the data used. The most obvious one is the short timeframe being analysed here. This is by necessity rather than choice and is due to the lack of VKT per capita data earlier than 2000. Consequently, I believe that any conclusions this research draws regarding correlation must be qualified with the disclaimer that the correlation has been established based upon relatively short timeframes.

This research also treats each dependent variable as being unrelated to all other independent variables when that is not necessarily the case. This is particularly so for the economic indicators. For instance, this research treats GDP per capita and the unemployment rate as being unrelated, when in reality there is a correlative relationship between the two, and perhaps a causal relationship as well.

3.4 Linear regression method

The analysis used a linear regression method. In each instance, one dependent and one independent variable were used. The dependent variable used was always VKT per capita as the goal of this research is to determine how VKT per capita changes when compared to changes in another variable. Rather than consider multiple independent variables at the same time, this research instead repeated this process for each independent variable, having one variable at a time compared against VKT per capita.

Only later were multiple indicators selected at once. Four outputs were selected: model fit, descriptive, estimates, and confidence intervals, which were set at 95%.

Chapter 4

Results

This chapter will provide the relevant results from the analysis using SPSS, with some explanation as to what these numbers all mean. The full results produced by SPSS are however in the appendices.

4.1 GDP per capita

This section contains the results for the analysis of GDP per capita and its correlation to VKT per capita. Full results are shown in Appendix A.

4.1.1 Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9416.1333	222.78204	15
GPDpercapita	30813.0000	9116.82564	15

The table above is a simple summary of the data that was used as the model's input. This simply shows the mean VKT per capita and GDP per capita figures, and a standard deviation. The VKT per capita standard deviation of approximately 222 is rather low, so there is relatively little change to the figure over time. By contrast, the standard deviation for GDP per capita is relatively higher, at roughly 1/3 of the mean. This higher standard deviation for GDP per capita may already suggest a weak correlation between these two datasets; one would expect if there was a strong correlation that there would not be such a gulf in the relative standard deviation.

4.1.2 Correlations

		VKTpercapita	GPDpercapita
Pearson Correlation	VKTpercapita	1.000	-.585
	GPDpercapita	-.585	1.000
Sig. (1-tailed)	VKTpercapita	.	.011

	GPDpercapita	.011	.
N	VKTpercapita	15	15
	GPDpercapita	15	15

The relevant result here is the -.585 correlation between the two. This figure represents a negative correlation, meaning that as GDP per capita increases, VKT per capita decreases. The actual correlation of -.585 suggests a moderately strong correlation (as -1 is a total negative correlation, and 1 is a total positive correlation. This is an interesting result, because it is contrary to what the literature suggests the relationship ought to be between these two indicators; as GDP per capita increases, so should VKT per capita. However, this result shows that in New Zealand's case, the opposite may be true.

4.1.3 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.585	.342	.291	187.56838

The R Square of .342 indicates a weak relationship with the regression line, further suggesting that there is not a strong relationship between these two indicators, and that the GDP data does not fit the model especially well.

4.2 Unemployment rate

Next is the analysis of the results pertaining to VKT per capita when analysed against unemployment rate. Full results are shown in Appendix B.

4.2.1 Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9416.1333	222.78204	15
Unemploymentrate	5.0420	.95325	15

One notable aspect of these descriptive statistics is the relatively large standard deviation for the unemployment rate from the mean when compared with the standard deviation for VKT per capita. Again, this relatively large standard deviation may suggest a weaker correlation.

4.2.2 Correlations

		VKTpercapita	Unemploymentrate
Pearson Correlation	VKTpercapita	1.000	-.891
	Unemploymentrate	-.891	1.000
Sig. (1-tailed)	VKTpercapita	.	.000
	Unemploymentrate	.000	.
N	VKTpercapita	15	15
	Unemploymentrate	15	15

However, that assumption was not reflected in the Pearson correlation, which as shown here is -.891. This suggests a strong negative relationship between the unemployment rate and VKT per capita. In other words, as the unemployment rate decreases, VKT per capita increases, and vice versa. This is what one would expect; as the more people that are employed, the more reason there is to travel. This not only includes commuting to and from work, but also travel that is enabled by greater income.

4.2.3 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.891	.794	.778	105.01772

The R Square of .794 indicates a strong relationship with the regression line, further suggesting that there is a strong relationship between these two indicators, and that the GDP data generally fits both the regression line and the model well.

4.3 Petrol retail price

This section outlines the results of the analysis of the relationship between VKT per capita and the retail price for petrol. Full results are shown in Appendix C.

4.3.1 Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9399.3333	243.12561	12
Petrolretailprice	175.1608	31.29200	12

Again, the standard deviation from the mean is higher for the petrol retail price than for VKT per capita, though not by as much of a margin as for previous indicators. This itself could possibly indicate a closer relationship between the two indicators, if increases and decreases align.

4.3.2 Correlations

		VKTpercapita	Petrolretailprice
Pearson Correlation	VKTpercapita	1.000	-.922
	Petrolretailprice	-.922	1.000
Sig. (1-tailed)	VKTpercapita	.	.000
	Petrolretailprice	.000	.
N	VKTpercapita	12	12
	Petrolretailprice	12	12

What stands out about this result is the extremely strong negative correlation of -.922 between the two indicators. This suggests as very strong relationship between increasing petrol retail prices and decreasing VKT per capita. This is a relationship that was been discussed frequently in the literature and makes sense: if petrol is expensive to buy, motorists will travel less. This is perhaps the strongest result of the analysis and will be discussed in more detail in the next chapter.

4.3.3 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.922	.851	.836	98.54070

The R Square of .851 indicates a very strong relationship with the regression line, indicating that there is a strong relationship between these two indicators, and that the petrol price fits both the regression line and the model very well.

4.4 Building consents granted

This section outlines the key results derived from analysing the relationship between annual building consents granted and VKT per capita. Full results are shown in Appendix D.

4.4.1 Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9416.1333	222.78204	15
Buildingconsents	22590.8000	5735.06281	15

The standard deviation for the number of building consents granted is relatively high compared with the standard deviation for VKT; this suggests the relationship may not be especially strong.

4.4.2 Correlations

		VKTpercapita	Buildingconsents
Pearson Correlation	VKTpercapita	1.000	.714
	Buildingconsents	.714	1.000
Sig. (1-tailed)	VKTpercapita	.	.001
	Buildingconsents	.001	.
N	VKTpercapita	15	15
	Buildingconsents	15	15

The correlation of .714 is moderately strong, and the positive nature of the relationship indicates that as the number of building consents granted increases, so does VKT per capita. This is what one would expect; assuming most new building consents are for greenfield developments, if more are granted then the urban area will increase, leading to an increase in VKT per capita.

4.4.3 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.714	.510	.472	161.89431

The R Square of .510 indicates a weak relationship with the regression line, indicating that there is a not an especially strong relationship between these two factors.

4.5 Tertiary education enrolment

This section outlines the key results derived from analysing the relationship between tertiary education enrolment and VKT per capita. Full results are shown in Appendix E.

4.5.1 Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9369.0000	229.94695	11
Tertiaryenrolment	11.8518	1.47367	11

Compared to most of indicators, the tertiary enrolment rate deviates from the mean by a modest amount.

4.5.2 Correlations

		VKTpercapita	Tertiaryenrolment
Pearson Correlation	VKTpercapita	1.000	.805

	Tertiaryenrolment	.805	1.000
Sig. (1-tailed)	VKTpercapita	.	.001
	Tertiaryenrolment	.001	.
N	VKTpercapita	11	11
	Tertiaryenrolment	11	11

Again, there is a strong correlation here; .805 represents a strong positive correlation that suggests that an increase in tertiary enrolment leads to an increase in VKT per capita, and vice versa. This is interesting because it contradicts established case studies, such as those from Germany. Based off the literature, one would expect VKT per capita to go down as the tertiary education rate increases, as students generally travel by car less and may forsake car ownership entirely.

4.5.3 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.805	.647	.608	143.91039

The R Square of .647 indicates only a moderate relationship with the regression line, indicating that there is not a strong relationship between these two indicators.

4.6 Licence attainment

This section outlines the results derived from analysing the relationship between licence attainment and VKT per capita. Full results are shown in Appendix F.

4.6.1 Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9416.1333	222.78204	15
Driverslicencesheld	57.9093	6.46255	15

Compared to most of indicators, the licence attainment rate deviates from the mean by a modest amount.

4.6.2 Correlations

		VKTpercapita	Driverslicencesheld
Pearson Correlation	VKTpercapita	1.000	.626
	Driverslicencesheld	.626	1.000
Sig. (1-tailed)	VKTpercapita	.	.006
	Driverslicencesheld	.006	.
N	VKTpercapita	15	15
	Driverslicencesheld	15	15

The analysis produced a result of 0.626 for the correlation. This indicates a moderately strong positive relationship, meaning that as licence attainment increases, so does VKT per capita. This is to be expected; the more people who have licences, the more drivers there will be on the roads. However, the correlation is lower than one might expect, given the strong connections in the academic literature between lower licence attainment and lower VKT per capita.

4.6.3 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.626	.391	.344	180.37464

The R Square of .391 indicates only a weak relationship with the regression line, indicating that there is not a strong relationship between these two indicators at all.

4.7 Aviation emissions

Finally, this section outlines the results of the analysis of the correlation between VKT per capita and aviation emissions. Full results are shown in Appendix G.

4.7.1 Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9416.1333	222.78204	15
Aviationemissions	1052.4667	159.30289	15

Again, there is a relatively large standard deviation from the mean for aviation emissions when compared with the relative standard deviation from VKT per capita.

4.7.2 Correlations

		VKTpercapita	Aviationemissions
Pearson Correlation	VKTpercapita	1.000	.766
	Aviationemissions	.766	1.000
Sig. (1-tailed)	VKTpercapita	.	.000
	Aviationemissions	.000	.
N	VKTpercapita	15	15
	Aviationemissions	15	15

The correlation of .766 suggests a strong (but not extremely strong) correlation between the two indicators, with a positive relationship. The results suggest that as aviation emissions increase, VKT per capita also increases. This is contrary to the assumptions that underlie the relationship; one would assume that higher aviation emissions would correlate with lower VKT per capita, with the rationale being people would be flying rather than driving long distances. This result suggests that relationship does not seem to exist in New Zealand.

4.7.3 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.766	.587	.555	148.62382

The R Square of .587 indicates a moderately strong relationship with the regression line.

4.8 Multiple Indicator Analyses

As it is possible that one indicator alone is unable to explain the trends we see in VKT per capita, this research also included some analysis of multiple indicators simultaneously. In each instance, two indicators with relatively high correlations were selected.

4.8.1 Petrol Price and Unemployment

As both of these indicators produced high correlations when analysed individually, they have also been analysed together against VKT per capita. Full results can be found in Appendix H.

Correlations

		VKTpercapita	Petrolretailprice	Unemploymentrate
Pearson Correlation	VKTpercapita	1.000	-.922	-.916
	Petrolretailprice	-.922	1.000	.726
	Unemploymentrate	-.916	.726	1.000
Sig. (1-tailed)	VKTpercapita	.	.000	.000
	Petrolretailprice	.000	.	.004
	Unemploymentrate	.000	.004	.
N	VKTpercapita	12	12	12
	Petrolretailprice	12	12	12
	Unemploymentrate	12	12	12

The only new figure here worth noting is the .726 correlation between petrol retail price and unemployment rate, which suggests both a fairly strong relationship between the two and that as one increases, so would the other. This makes sense; as petrol becomes more expensive then so does travelling to work as well as the costs of doing business, such as transporting goods and services. The latter may result in higher costs and thus the need to lay off staff for businesses to stay profitable.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.989	.979	.974	38.98000

This model is interesting in that the overall R and R-square are both very high. This suggests not only a strong correlation but also a good fit with the model.

4.8.2 Petrol Price and Building Consents Granted

Again, both of these indicators produced relatively high correlations when analysed individually. Full results can be found in Appendix I.

Correlations

		VKTpercapita	Petrolretailprice	Buildingconsents
Pearson Correlation	VKTpercapita	1.000	-.922	.694
	Petrolretailprice	-.922	1.000	-.534
	Buildingconsents	.694	-.534	1.000
Sig. (1-tailed)	VKTpercapita	.	.000	.006
	Petrolretailprice	.000	.	.037
	Buildingconsents	.006	.037	.
N	VKTpercapita	12	12	12
	Petrolretailprice	12	12	12
	Buildingconsents	12	12	12

These results suggest a weak relationship between the retail price for petrol and the number of building consents granted annually.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.953	.908	.887	81.74615

Again, the overall R and R-square are both very high. This suggests not only a strong correlation but also a good fit with the model.

Chapter 5

Discussion

This chapter will discuss the research results in depth and will seek to place the research findings in the broader body of literature, either supporting existing conclusions or arguing that New Zealand is different to other countries.

5.1 Economic indicators

This research examined three economic indicators: GDP per capita, unemployment rate, and average retail price for petrol. Two of these indicators (GDP per capita and petrol prices) have been examined multiple times by several scholars in the literature, and scholars have tended to conclude that these two indicators are most likely to explain the trends in VKT per capita that we see.

Goodwin & Van Dender (2013), Bastian & Borjesson (2015) and Bastian et al (2016) are all advocates in the literature of GDP per capita being a main driving factor in the changing patterns in VKT, although Kenworthy (2013) argues this is not the case. One would expect a close and positive relationship between GDP per capita and VKT per capita; as an economy grows, there is more reason to travel and more people have more disposable income. As an economy shrinks, the opposite is true. We would thus expect increases in GDP per capita to be correlated to increases in VKT per capita, and vice versa.

However, as noted in the previous chapter, this has not been the case in New Zealand. Not only was the relationship between the two indicators only moderately strong, it was also negative rather than positive. In other words, the results of this analysis showed that increasing GDP per capita actually correlated with decreasing VKT per capita. This is totally contrary to the findings of most scholars and suggests that in the case of New Zealand there may be some validity to Kenworthy's claims that GDP and VKT are becoming decoupled. Certainly, the results of this analysis do not show any significant correlation between the two indicators, with a weak correlation and a relationship that is the inverse of what was expected.

The relationship between the unemployment rate and VKT per capita is not discussed in the literature; its use as an indicator in this research is a new initiative. The rationale behind its use and the possible connection is simple: as unemployment rises, people have less reason to travel (to and from jobs) and also less income to spend (again, less travel). This seems to be borne out in the very strong negative relationship that the analysis showed between VKT per capita and the unemployment rate. This suggests a strong correlation between increasing unemployment and decreasing VKT per capita, and vice versa.

This relationship is especially interesting as one would expect GDP per capita and unemployment to be related to a degree; high GDP per capita should coincide with low unemployment, and vice versa. The result here however showed a much stronger relationship between VKT per capita and the unemployment rate than between GDP per capita and VKT per capita. This may suggest that not only has VKT become detached from GDP in New Zealand, as Kenworthy (2013) suggests, but that GDP may also be decoupled somewhat from other economic indicators, such as the unemployment rate.

The correlation between fuel price and VKT per capita was the strongest result produced by this research, and this adds weight to the conclusions reached by BITRE (2012) and Bastian & Borjesson (2015), who all concluded that petrol prices played a significant role in driving VKT trends. The result of -.922 reflects an extremely strong negative relationship, meaning that as fuel prices increase then VKT decreases, and vice versa. This is what one would expect: as driving becomes more expensive due to more expensive fuel, people will drive less. This research supports the analysis done by the aforementioned scholars and suggests that New Zealand may not be unique in what drives change in VKT. As was noted in BITRE's report, fuel prices had strong explanatory power across a wide number of developed nations.

What is interesting though is that BITRE concluded that the price of petrol was not significant in the modelling done on New Zealand's VKT and possible future VKT trends. However, that does not mean the two are not correlated, but merely suggests that petrol price may lack strong explanatory power.

5.2 Spatial indicators

While there is much academic literature concerning spatial changes and the impact this has on VKT, there is very little (if any) that has attempted to quantify a statistical relation between these factors and VKT. The academic literature focuses on urban density and the impact of sprawl versus infill on VKT – the works of Headicar and Metz, for instance. However, the lack of any kind of spatial data for New Zealand's cities that might quantify their sprawl means this research has to make do with a proxy.

This research needed to use a proxy spatial indicator, the number of building consents granted annually. The rationale was that a higher number of building consents should indicate greater greenfield development and thus greater sprawl. This would require greater distances to be travelled by car, thus increasing VKT per capita. This research suggests that this relationship is borne out in New Zealand, with a positive correlation between the two indicators. With the said, the correlation itself is only moderately strong, suggesting that other indicators here may have more explanatory power.

Second, this result does not necessarily mean that spatial factors are not a key part of the reason for New Zealand's declining VKT trends; this analysis has to make use of a proxy indicator, and analysis using more direct indicators may produce different results.

5.3 Social indicators

While this research produced a strong relationship between tertiary enrolment and VKT per capita, the relationship was the inverse of what the literature suggests it ought to be. Kuhnimhof et al (2012) have argued that tertiary education enrolment has an inverse relationship with VKT per capita. In other words, as tertiary enrolment increases, VKT should decrease. However, in New Zealand the two indicators have largely aligned with one another: both have gradually decreased over the time period analysed. This suggests that in New Zealand changes in tertiary education patterns may not be linked to VKT. This distinguishes New Zealand from European nations where there is such a relationship.

The results showed a comparatively weak relationship between VKT and driver licence attainment. The relationship was positive, as expected, as both indicators are decreasing over time. However, the weak relationship does not align with literature's conclusion that there is a causal relationship. So, while the trends and relationship between these two indicators may be similar in New Zealand to overseas, it seems that the relationship is not strong enough to offer a significant correlation.

The idea that people choosing to travel by air might affect VKT seems to be rejected by these results. The relationship was somewhat strong, and showed a positive relationship, meaning that aviation emissions (the proxy used here) have decreased alongside VKT. It is difficult to draw a conclusion from this; this could mean that people are not flying instead of driving, or it could mean that more people are flying rather than driving, but gains in aircraft efficiency are offsetting this greater use of air travel.

5.4 Multiple Indicators

The two analyses using multiple indicators against VKT produced higher correlations than when a single variable was compared against VKT per capita. This may suggest that multiple factors have more explanatory power and stronger relationships with the VKT trends compared to a single factor.

The literature has generally avoided examining several different indicators or factors, instead focusing on one individual cause, such as licence attainment or petrol prices. This result raises the possibility of there being a gap in the existing literature and the understanding it gives due to scholars generally not examining multiple potential causes of the changing VKT patterns.

5.5 Summary

All in all, the results suggest that economic factors may have some connection with the trends in VKT per capita that we see. While the correlation between GDP per capita and VKT per capita was both somewhat weak and perplexing in its implication, the correlations between VKT per capita and the unemployment rate and the average retail petrol price were both much stronger and reflected the expected explanations. The explanation given by the literature that petrol retail prices may be a key driver of changes in VKT is certainly reflected in these results. The finding that there is also a strong relationship between VKT per capita and the unemployment rate is interesting, as it suggests there may be another avenue of research for other scholars in the future.

All in all, this research suggests that in the case of New Zealand economic factors are more important than social factors. This aligns New Zealand with other Anglophone countries and distinguishes us from European nations such as Germany.

Chapter 6

Conclusions

There are several conclusions that can be drawn from this research; some significant and some less significant.

6.1 The New Zealand Case

In contrast to some countries (especially in Europe), New Zealand's changing VKT trends seem to be attributable largely or exclusively to economic trends and changes rather than social trends. In particular, there is a very strong link between the unemployment rate and VKT per capita, and between fuel prices and VKT per capita.

This may suggest that New Zealanders are less likely to change their habits based on social change and respond most strongly to economic factors.

6.2 Policy and planning ramifications

For planners and policy makers who may want to reduce car travel and VKT in New Zealand, this research suggests the best way to go about this is through economic measures. While increasing unemployment deliberately is not a politically acceptable suggestion, increasing the price of petrol would likely be effective. Recent petrol price and VKT trends in New Zealand show that New Zealanders drive less when petrol price increases and drive more when it decreases. Taxes and other means of increasing the petrol price could prove to be effective means of further reducing vehicle travel, if that is what policymakers seek to achieve.

6.3 Further research opportunities

There are significant opportunities for future research in this area. First and foremost, the conclusion reached by this research is based on relatively limited data and the use of proxy indicators when publicly accessible data was lacking. A deeper investigation into the indicators used here using more comprehensive data from a longer time frame may produce different results or may confirm the existing analysis. Given that the results obtained here were based on fifteen years of data, the results are inherently based off limited data. More thorough analysis with more data would serve to strengthen the conclusions reached here, or formidably challenge them.

Another possible direction for future research could be incorporating qualitative social factors that are difficult or impossible to quantify. Scholars have identified the impact of digital technology as one potential significant driver for changes in VKT trends. As explained above, younger people in particular may use social media to connect with friends without needing to travel or use online shopping rather than going to 'brick and mortar' shops to buy things. These changes in behaviour could potentially help explain the changing patterns in VKT per capita. The difficulty of course is that these are very difficult to quantify and would require a qualitative method to investigate. Future research could follow this avenue and help determine whether such changes may apply to New Zealand.

6.4 Concluding remarks

While these results should be accepted with a degree of caution, given the short data set timeframe that was used, this research has nonetheless produced a compelling result that lends credibility to the idea that economic indicators are most closely related to VKT in New Zealand, while social trends may not be applicable. Despite this, more research needs to be done in this area to confirm or contradict this study's findings. Doing so is important, as the greater certainty would provide a clearer picture for planners and policymakers as New Zealand transitions to a lower carbon economy.

Appendix A

GDP per capita – raw results

Regression

Notes

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	Cases Used	Statistics are based on cases with no missing values for any variable used.

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Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9416.1333	222.78204	15
GPDpercapita	30813.0000	9116.82564	15

Correlations

		VKTpercapita	GPDpercapita
Pearson Correlation	VKTpercapita	1.000	-.585
	GPDpercapita	-.585	1.000
Sig. (1-tailed)	VKTpercapita	.	.011
	GPDpercapita	.011	.

N	VKTpercapita	15	15
	GPDpercapita	15	15

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	GPDpercapita[b]	.	Enter

a. Dependent Variable: VKTpercapita

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.585[a]	.342	.291	187.56838

a. Predictors: (Constant), GPDpercapita

b. Dependent Variable: VKTpercapita

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	9856.324	176.214		55.934	.000
	GPDpercapita	-.014	.005	-.585	-2.598	.022

Coefficients[a]

Model		95.0% Confidence Interval for B	
		Lower Bound	Upper Bound
1	(Constant)	9475.637	10237.011
	GPDpercapita	-.026	-.002

a. Dependent Variable: VKTpercapita

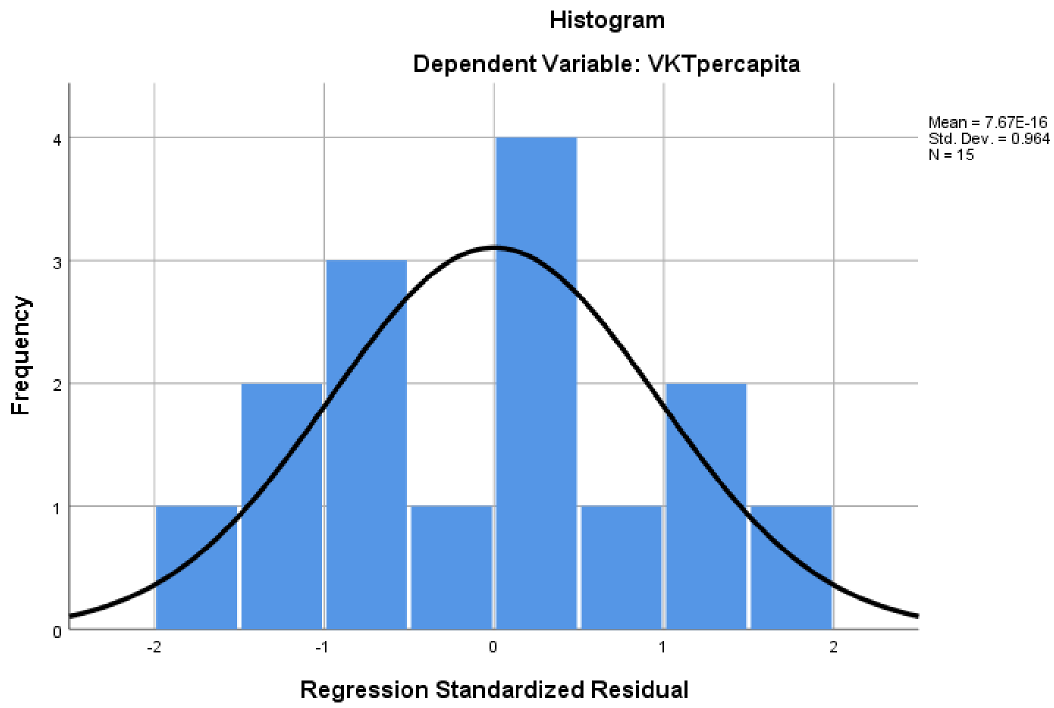
Residuals Statistics[a]

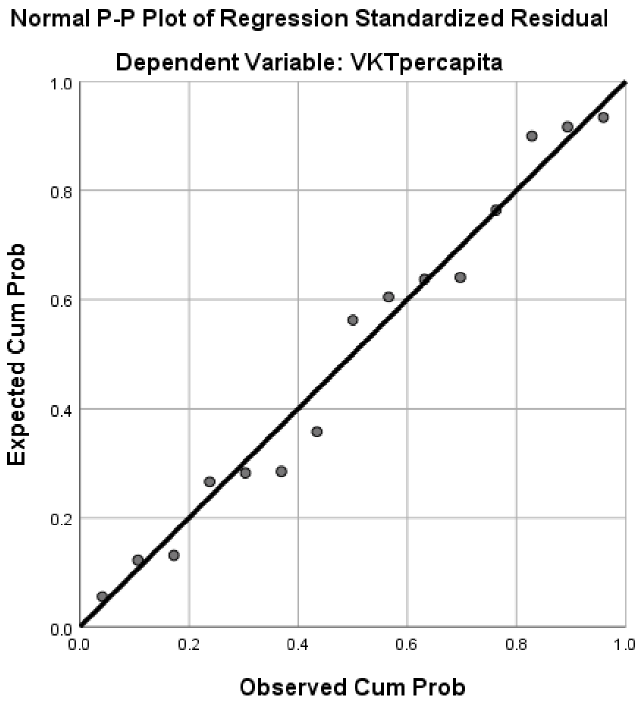
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	9220.5596	9657.9932	9416.1333	130.24183	15

Residual	-298.99319	282.10980	.00000	180.74541	15
Std. Predicted Value	-1.502	1.857	.000	1.000	15
Std. Residual	-1.594	1.504	.000	.964	15

a. Dependent Variable: VKTpercapita

Charts




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: VKTpercapita
Expected Cum Prob
Observed Cum Prob
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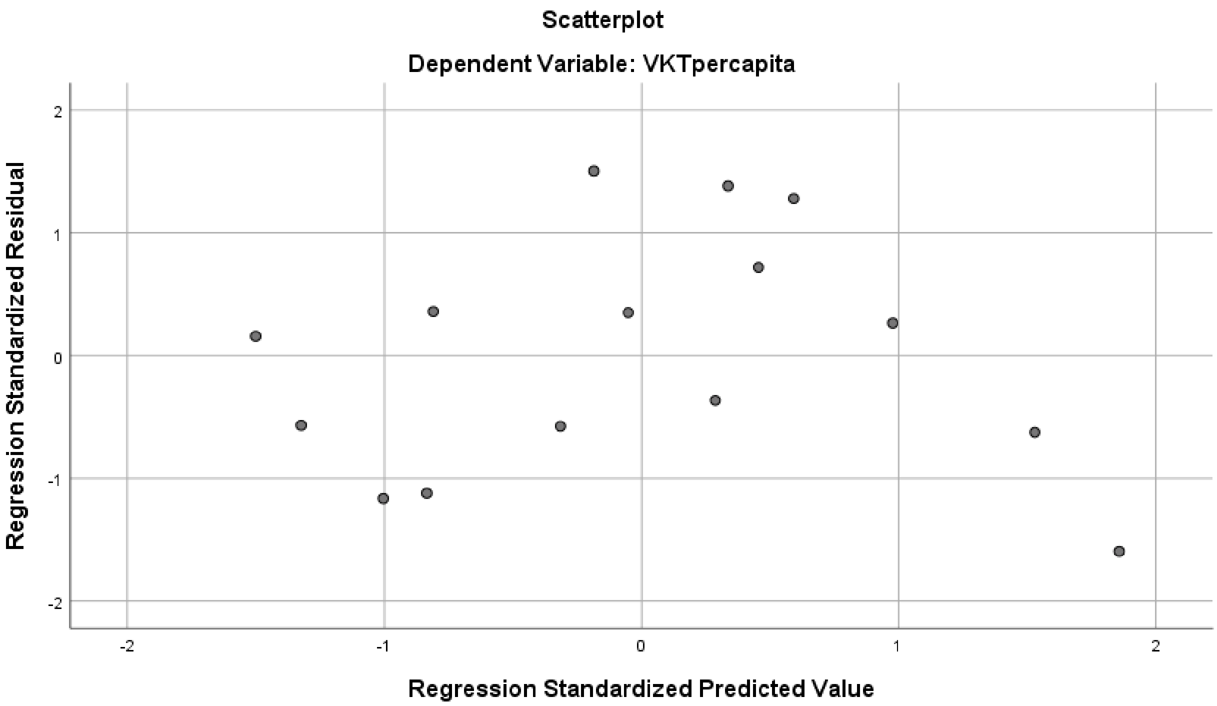
0.6
0.8
1.0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Dependent Variable: VKTpercapita
Regression Standardized Residual
Regression Standardized Predicted Value
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0
1
2

Appendix B

Unemployment rate – raw results

Regression

Notes

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	N of Rows in Working Data File	15
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.

Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT VKTpercapita /METHOD=ENTER Unemploymentrate /SCATTERPLOT=(*ZRESID ,*ZPRED) /RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).
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	Additional Memory Required for Residual Plots	680 bytes

Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9416.1333	222.78204	15
Unemploymentrate	5.0420	.95325	15

Correlations

		VKTpercapita	Unemploymentrate
Pearson Correlation	VKTpercapita	1.000	-.891
	Unemploymentrate	-.891	1.000
Sig. (1-tailed)	VKTpercapita	.	.000
	Unemploymentrate	.000	.
N	VKTpercapita	15	15
	Unemploymentrate	15	15

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Unemploymentrate[b]	.	Enter

a. Dependent Variable: VKTpercapita

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.891[a]	.794	.778	105.01772

a. Predictors: (Constant), Unemploymentrate

b. Dependent Variable: VKTpercapita

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10465.901	150.911		69.352	.000
	Unemploymentrate	-208.205	29.444	-.891	-7.071	.000

Coefficients[a]

Model		95.0% Confidence Interval for B	
		Lower Bound	Upper Bound
1	(Constant)	10139.878	10791.924
	Unemploymentrate	-271.814	-144.596

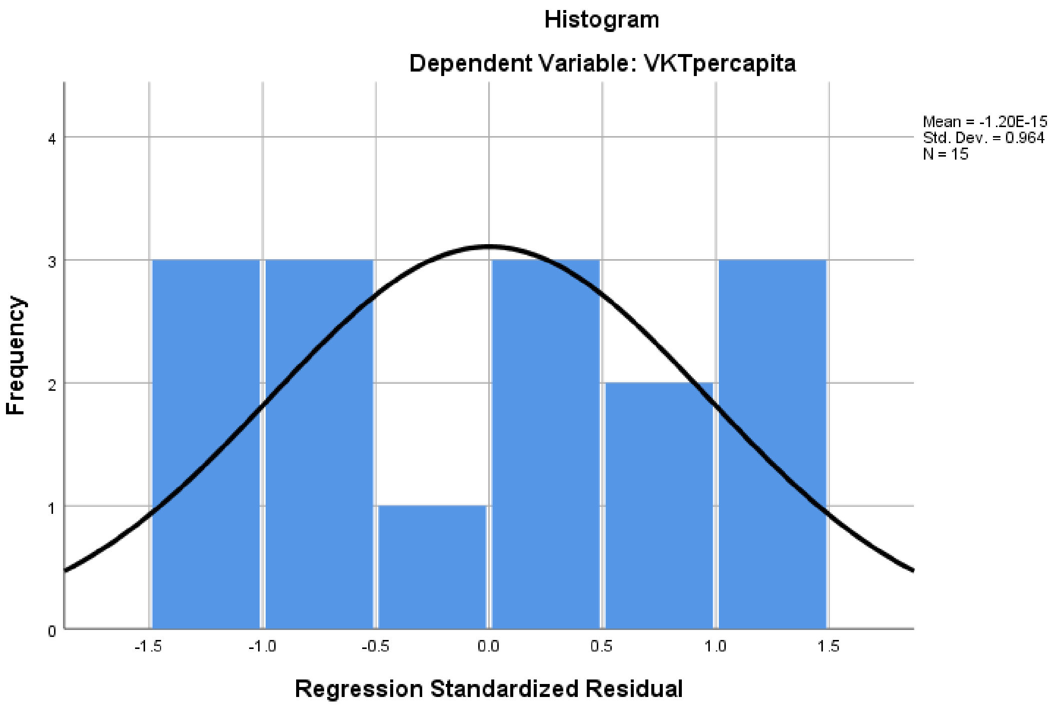
a. Dependent Variable: VKTpercapita

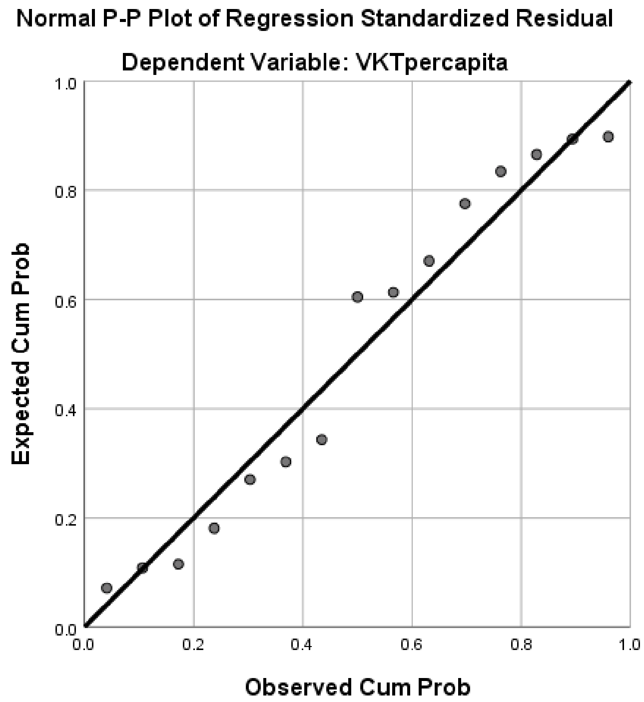
Residuals Statistics[a]

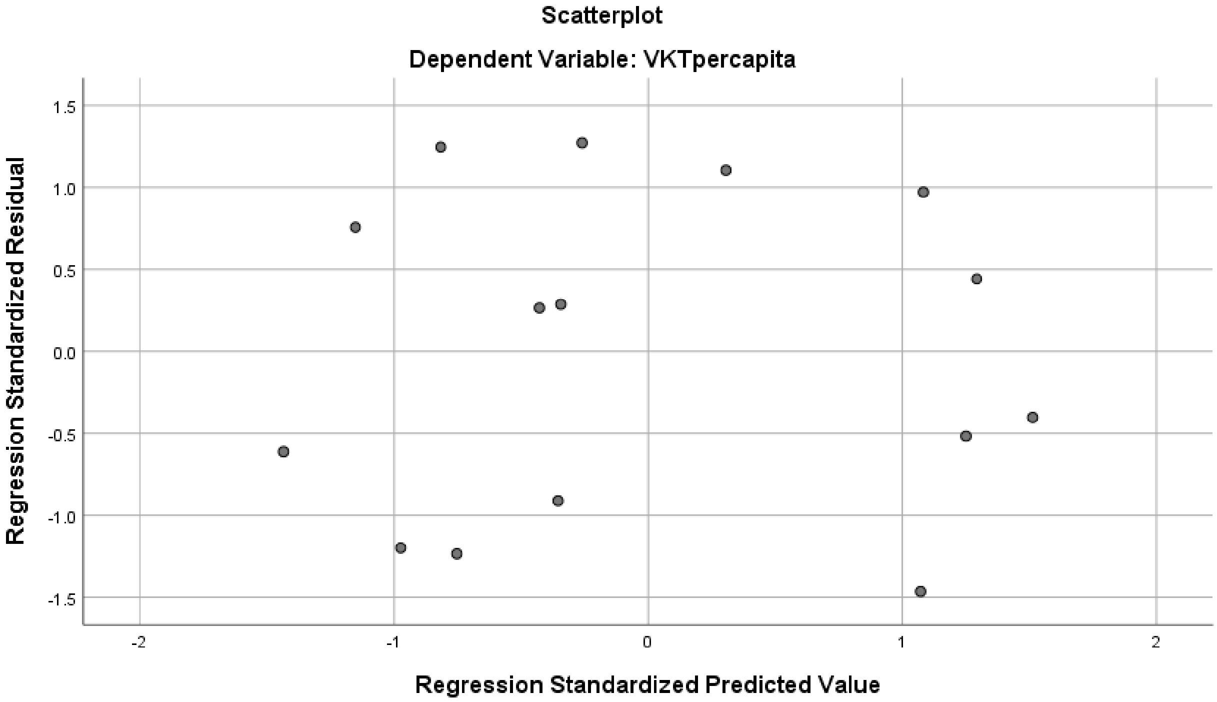
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	9131.3096	9716.3643	9416.1333	198.47137	15
Residual	-153.91844	133.50140	.00000	101.19760	15
Std. Predicted Value	-1.435	1.513	.000	1.000	15
Std. Residual	-1.466	1.271	.000	.964	15

a. Dependent Variable: VKTpercapita

Charts




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: VKTpercapita
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: VKTpercapita
Regression Standardized Residual
Regression Standardized Predicted Value
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2
-1
0
1
2

Appendix C **Petrol price – raw results**

Regression

Notes

Output Created		06-FEB-2018 09:50:26
Comments		
Input	Data	C:\Users\rshei\OneDrive\Documents\Masters Dissertation\Masters Data.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	15
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.
Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT VKTpercapita /METHOD=ENTER Petrolretailprice /SCATTERPLOT=(*ZRESID ,*ZPRED) /RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).

Resources	Processor Time	00:00:01.70
	Elapsed Time	00:00:01.63
	Memory Required	2640 bytes
	Additional Memory Required for Residual Plots	680 bytes

Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9399.3333	243.12561	12
Petrolretailprice	175.1608	31.29200	12

Correlations

		VKTpercapita	Petrolretailprice
Pearson Correlation	VKTpercapita	1.000	-.922
	Petrolretailprice	-.922	1.000
Sig. (1-tailed)	VKTpercapita	.	.000
	Petrolretailprice	.000	.
N	VKTpercapita	12	12
	Petrolretailprice	12	12

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Petrolretailprice[b]	.	Enter

a. Dependent Variable: VKTpercapita

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.922[a]	.851	.836	98.54070

a. Predictors: (Constant), Petrolretailprice

b. Dependent Variable: VKTpercapita

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	10654.532	168.727		63.147	.000
	Petrolretailprice	-7.166	.949	-.922	-7.547	.000

Coefficients[a]

Model		95.0% Confidence Interval for B Lower Bound	Upper Bound
1	(Constant)	10278.584	11030.479
	Petrolretailprice	-9.282	-5.050

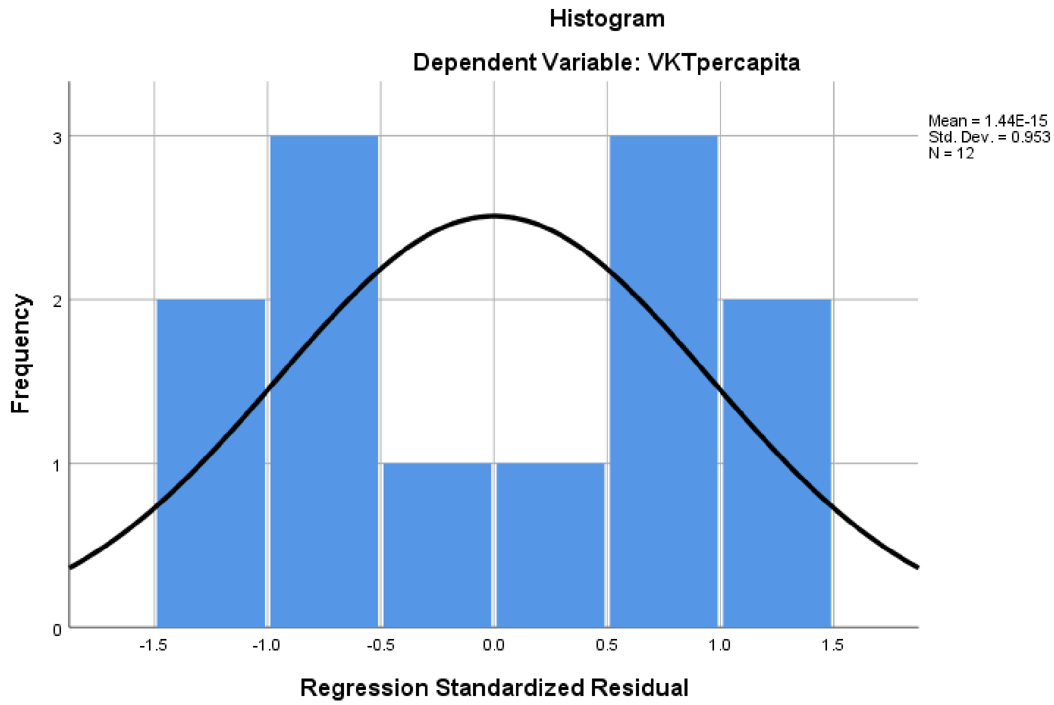
a. Dependent Variable: VKTpercapita

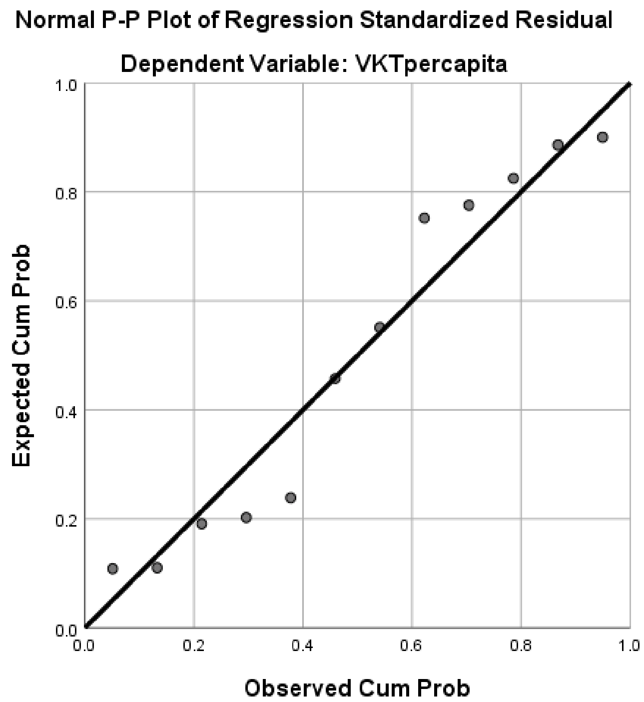
Residuals Statistics[a]

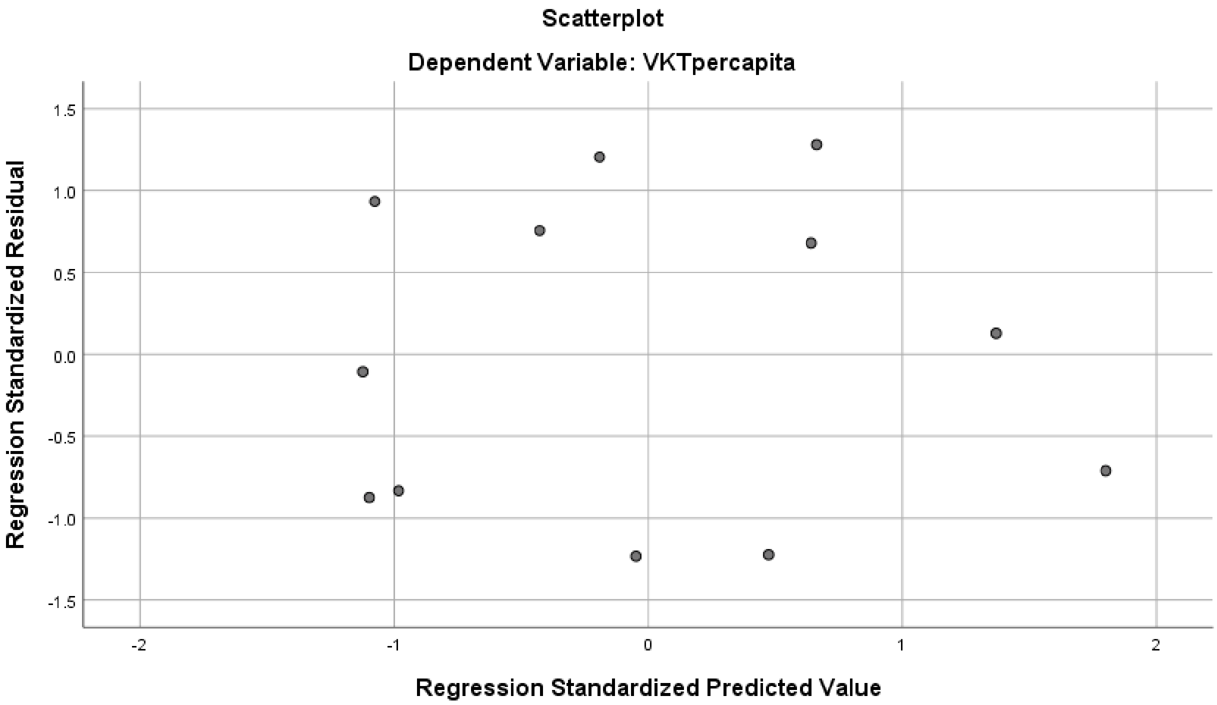
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	9147.5273	9802.9990	9399.3333	224.23769	12
Residual	-121.51868	126.11003	.00000	93.95487	12
Std. Predicted Value	-1.123	1.800	.000	1.000	12
Std. Residual	-1.233	1.280	.000	.953	12

a. Dependent Variable: VKTpercapita

Charts


Histogram
Dependent Variable: VKTpercapita
Mean = 1.44E-15
Std. Dev. = 0.953
N = 12
Frequency
Regression Standardized Residual
0
1
2
3
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5


Normal P-P Plot of Regression Standardized Residual
Dependent Variable: VKTpercapita
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: VKTpercapita
Regression Standardized Residual
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2
-1
0
1
2
Regression Standardized Predicted Value

Appendix D

Building consents granted – raw results

Regression

Notes

Output Created		15-APR-2018 18:52:57
Comments		
Input	Data	C:\Users\rshei\OneDrive\Documents\Masters Dissertation\Masters Data.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	15
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.

Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT VKTpercapita /METHOD=ENTER Buildingconsents /SCATTERPLOT=(*ZRESID ,*ZPRED) /RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).
Resources	Processor Time	00:00:03.08
	Elapsed Time	00:00:01.76
	Memory Required	2688 bytes
	Additional Memory Required for Residual Plots	680 bytes

```
[DataSet1] C:\Users\rshei\OneDrive\Documents\Masters Dissertation\Masters Data.sav
```

Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9416.1333	222.78204	15
Buildingconsents	22590.8000	5735.06281	15

Correlations

		VKTpercapita	Buildingconsents
Pearson Correlation	VKTpercapita	1.000	.714
	Buildingconsents	.714	1.000
Sig. (1-tailed)	VKTpercapita	.	.001
	Buildingconsents	.001	.

N	VKTpercapita	15	15
	Buildingconsents	15	15

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Buildingconsents[b]	.	Enter

a. Dependent Variable: VKTpercapita

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.714[a]	.510	.472	161.89431

a. Predictors: (Constant), Buildingconsents

b. Dependent Variable: VKTpercapita

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8789.658	175.487		50.087	.000
	Buildingconsents	.028	.008	.714	3.676	.003

Coefficients[a]

Model		95.0% Confidence Interval for B	
		Lower Bound	Upper Bound
1	(Constant)	8410.541	9168.775
	Buildingconsents	.011	.044

a. Dependent Variable: VKTpercapita

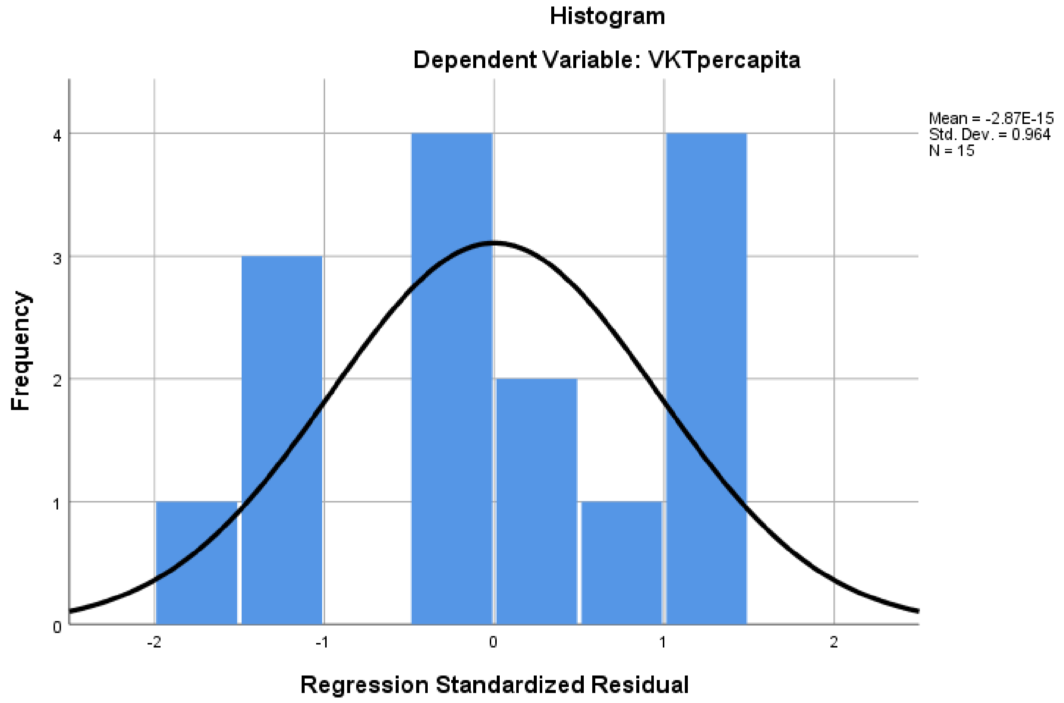
Residuals Statistics[a]

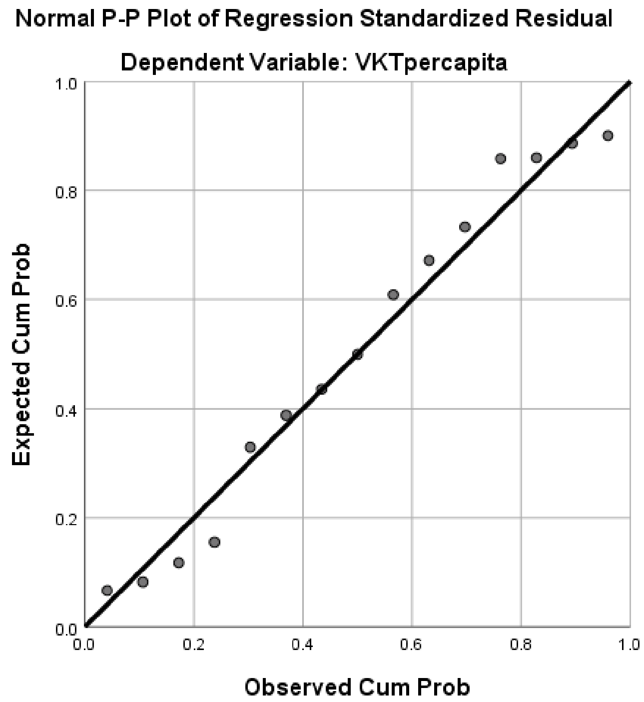
	Minimum	Maximum	Mean	Std. Deviation	N

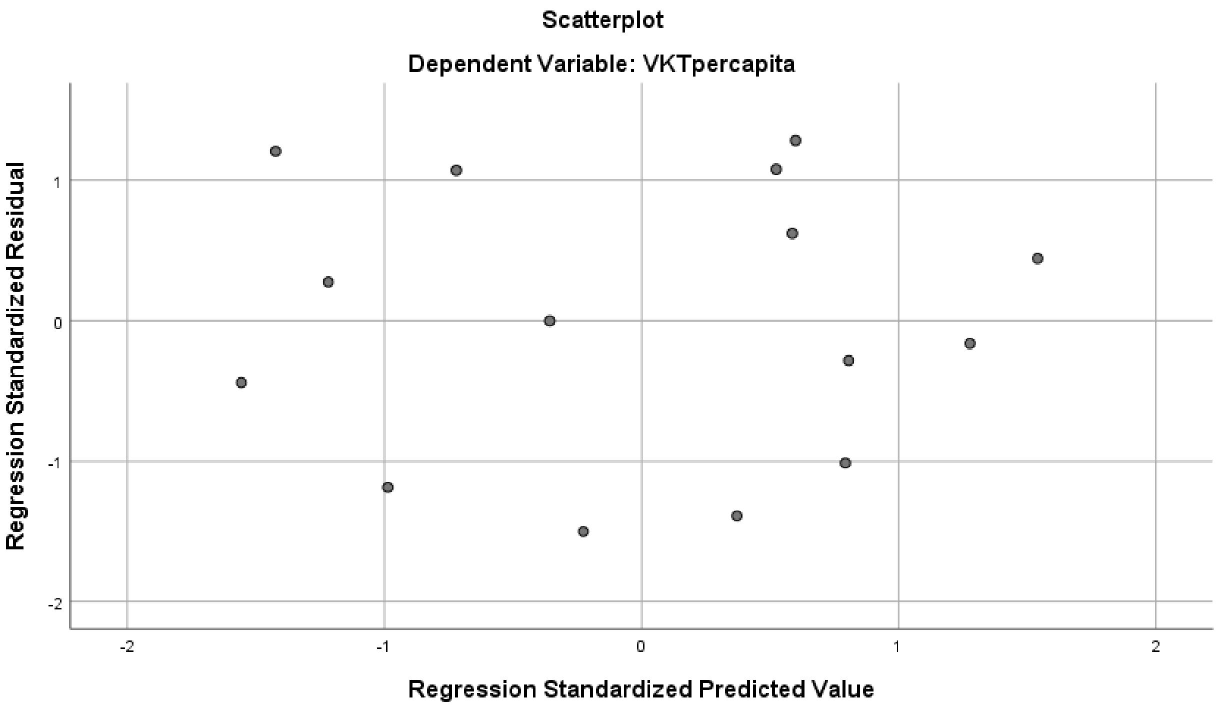
Predicted Value	9168.5254	9661.0625	9416.1333	159.04149	15
Residual	-243.06029	207.68686	.00000	156.00526	15
Std. Predicted Value	-1.557	1.540	.000	1.000	15
Std. Residual	-1.501	1.283	.000	.964	15

a. Dependent Variable: VKTpercapita

Charts




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: VKTpercapita
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: VKTpercapita
Regression Standardized Residual
Regression Standardized Predicted Value
-2
-1
0
1
2

Appendix E

Tertiary enrolment rates – raw results

Regression

Notes

Output Created		06-FEB-2018 09:47:37
Comments		
Input	Data	C:\Users\rshei\OneDrive\Documents\Masters Dissertation\Masters Data.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	15
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.

Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT VKTpercapita /METHOD=ENTER Tertiaryenrolment /SCATTERPLOT=(*ZRESID ,*ZPRED) /RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).
Resources	Processor Time	00:00:02.44
	Elapsed Time	00:00:01.73
	Memory Required	2640 bytes
	Additional Memory Required for Residual Plots	680 bytes

Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9369.0000	229.94695	11
Tertiaryenrolment	11.8518	1.47367	11

Correlations

		VKTpercapita	Tertiaryenrolment
Pearson Correlation	VKTpercapita	1.000	.805
	Tertiaryenrolment	.805	1.000
Sig. (1-tailed)	VKTpercapita	.	.001
	Tertiaryenrolment	.001	.
N	VKTpercapita	11	11
	Tertiaryenrolment	11	11

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Tertiaryenrolment[b]	.	Enter

a. Dependent Variable: VKTpercapita

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.805[a]	.647	.608	143.91039

a. Predictors: (Constant), Tertiaryenrolment

b. Dependent Variable: VKTpercapita

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	7880.909	368.560		21.383	.000
	Tertiaryenrolment	125.558	30.881	.805	4.066	.003

Coefficients[a]

Model		95.0% Confidence Interval for B	
		Lower Bound	Upper Bound
1	(Constant)	7047.168	8714.650
	Tertiaryenrolment	55.700	195.416

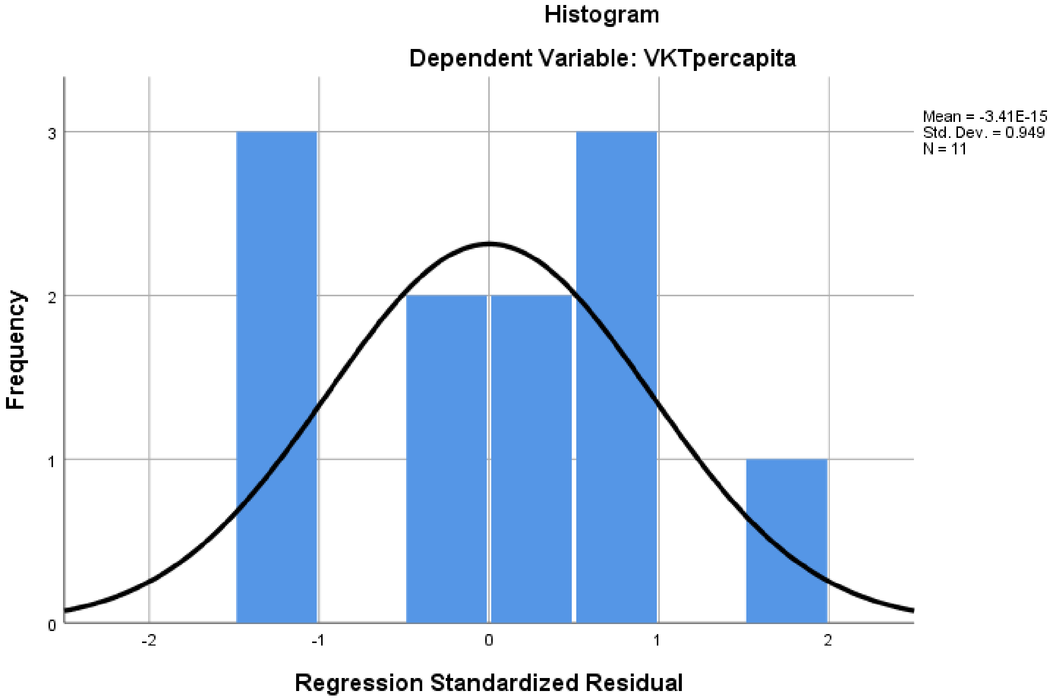
a. Dependent Variable: VKTpercapita

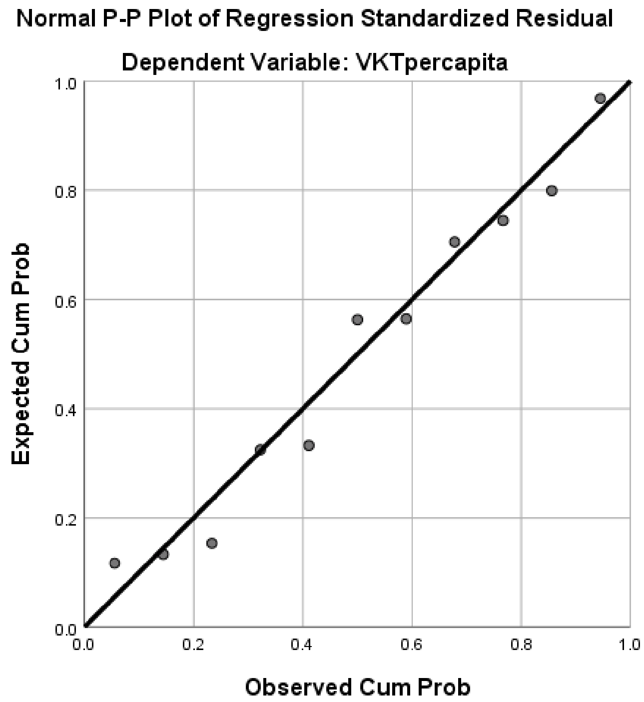
Residuals Statistics[a]

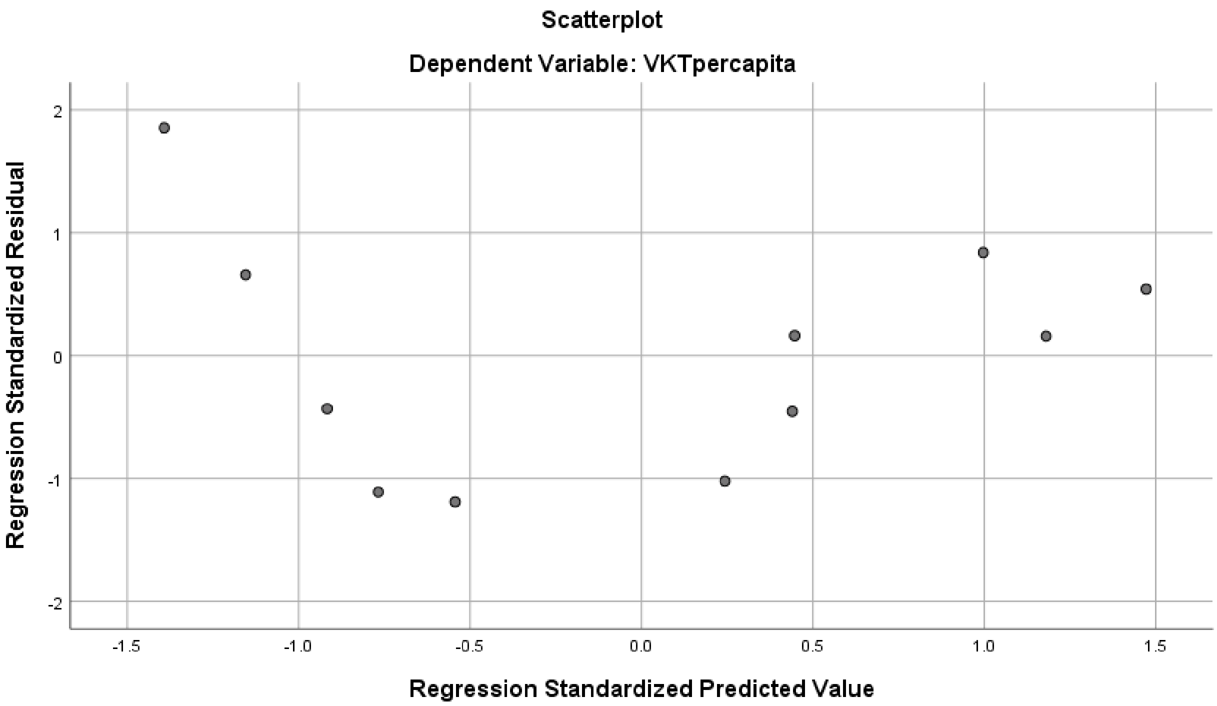
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	9111.3779	9641.2324	9369.0000	185.03086	11
Residual	-171.32526	266.62231	.00000	136.52538	11
Std. Predicted Value	-1.392	1.471	.000	1.000	11
Std. Residual	-1.190	1.853	.000	.949	11

a. Dependent Variable: VKTpercapita

Charts




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: VKTpercapita
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: VKTpercapita
Regression Standardized Residual
Regression Standardized Predicted Value
2
1
0
-1
-2
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5

Appendix F

Driver licence attainment – raw results

Regression

Notes

Output Created		06-FEB-2018 09:52:01
Comments		
Input	Data	C:\Users\rshei\OneDrive\Documents\Masters Dissertation\Masters Data.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	15
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.

Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT VKTpercapita /METHOD=ENTER Driverslicencesheld /SCATTERPLOT=(*ZRESID ,*ZPRED) /RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).
Resources	Processor Time	00:00:01.75
	Elapsed Time	00:00:01.75
	Memory Required	2640 bytes
	Additional Memory Required for Residual Plots	680 bytes

Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9416.1333	222.78204	15
Driverslicencesheld	57.9093	6.46255	15

Correlations

		VKTpercapita	Driverslicencesheld
Pearson Correlation	VKTpercapita	1.000	.626
	Driverslicencesheld	.626	1.000
Sig. (1-tailed)	VKTpercapita	.	.006
	Driverslicencesheld	.006	.
N	VKTpercapita	15	15
	Driverslicencesheld	15	15

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Driverslicencesheld[b]	.	Enter

a. Dependent Variable: VKTpercapita

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.626[a]	.391	.344	180.37464

a. Predictors: (Constant), Driverslicencesheld

b. Dependent Variable: VKTpercapita

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8167.377	434.476		18.798	.000
	Driverslicencesheld	21.564	7.459	.626	2.891	.013

Coefficients[a]

Model		95.0% Confidence Interval for B	
		Lower Bound	Upper Bound
1	(Constant)	7228.748	9106.005
	Driverslicencesheld	5.449	37.679

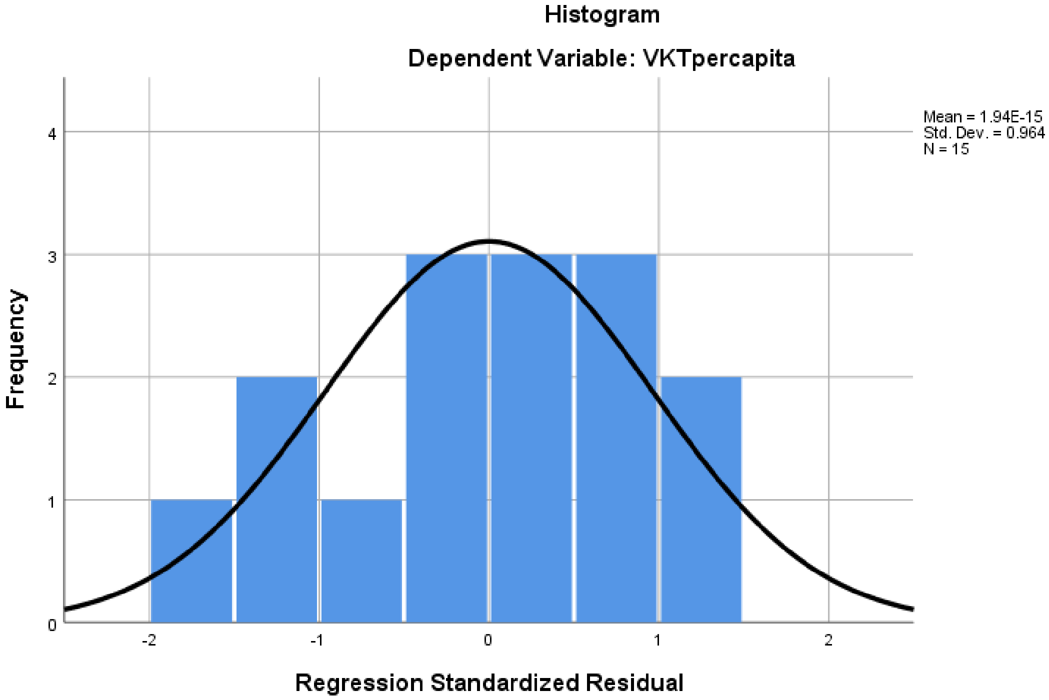
a. Dependent Variable: VKTpercapita

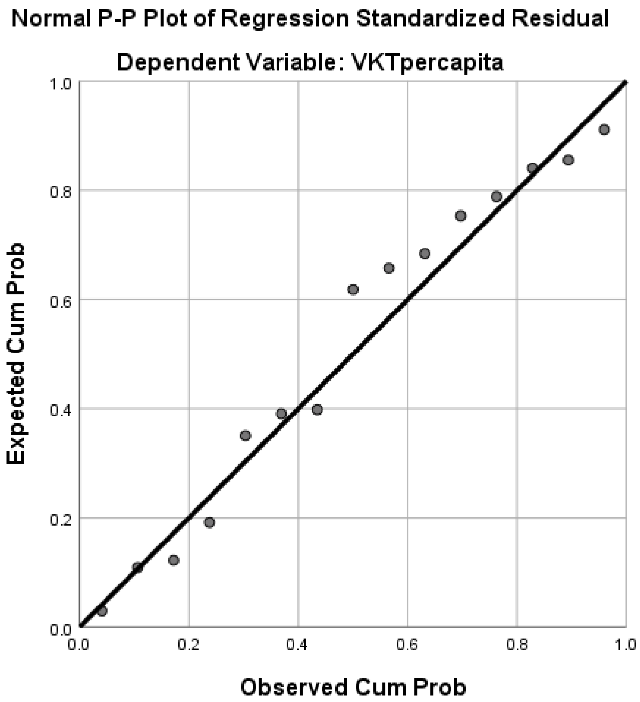
Residuals Statistics[a]

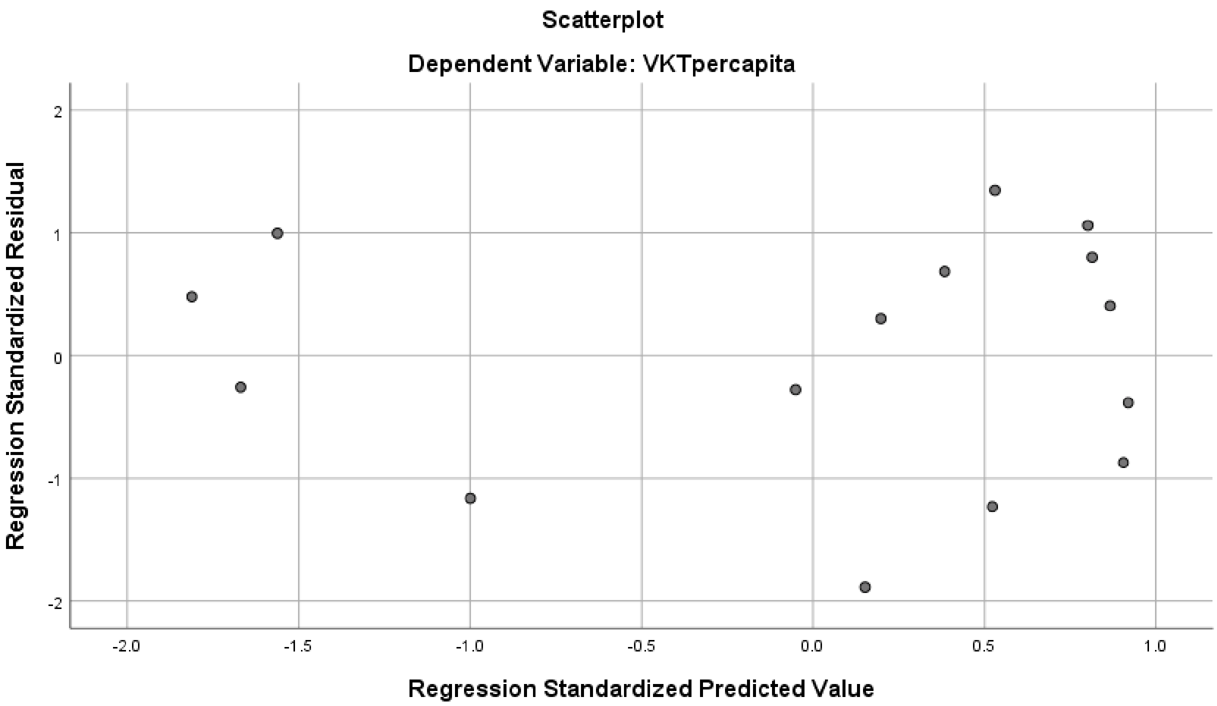
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	9163.6328	9544.2383	9416.1333	139.35837	15
Residual	-340.28043	242.88777	.00000	173.81336	15
Std. Predicted Value	-1.812	.919	.000	1.000	15
Std. Residual	-1.887	1.347	.000	.964	15

a. Dependent Variable: VKTpercapita

Charts




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: VKTpercapita
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: VKTpercapita
Regression Standardized Residual
Regression Standardized Predicted Value
2
1
0
-1
-2
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0

Appendix G

Aviation emissions – raw results

Regression

Notes

Output Created		06-FEB-2018 09:53:19
Comments		
Input	Data	C:\Users\rshei\OneDrive\Documents\Masters Dissertation\Masters Data.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	15
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.

Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT VKTpercapita /METHOD=ENTER Aviationemissions /SCATTERPLOT=(*ZRESID ,*ZPRED) /RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).
Resources	Processor Time	00:00:01.75
	Elapsed Time	00:00:01.65
	Memory Required	2640 bytes
	Additional Memory Required for Residual Plots	680 bytes

Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9416.1333	222.78204	15
Aviationemissions	1052.4667	159.30289	15

Correlations

		VKTpercapita	Aviationemissions
Pearson Correlation	VKTpercapita	1.000	.766
	Aviationemissions	.766	1.000
Sig. (1-tailed)	VKTpercapita	.	.000
	Aviationemissions	.000	.
N	VKTpercapita	15	15
	Aviationemissions	15	15

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Aviationemissions[b]	.	Enter

a. Dependent Variable: VKTpercapita

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.766[a]	.587	.555	148.62382

a. Predictors: (Constant), Aviationemissions

b. Dependent Variable: VKTpercapita

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	8288.716	265.218		31.252	.000
	Aviationemissions	1.071	.249	.766	4.296	.001

Coefficients[a]

Model		95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	7715.747	8861.685
	Aviationemissions	.533	1.610

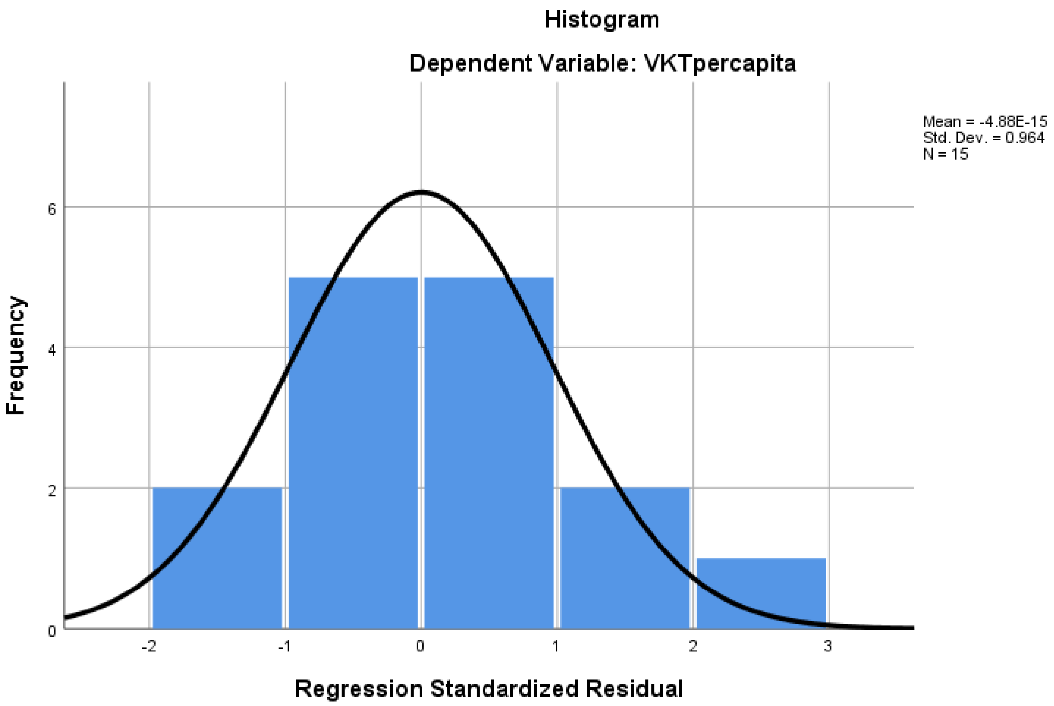
a. Dependent Variable: VKTpercapita

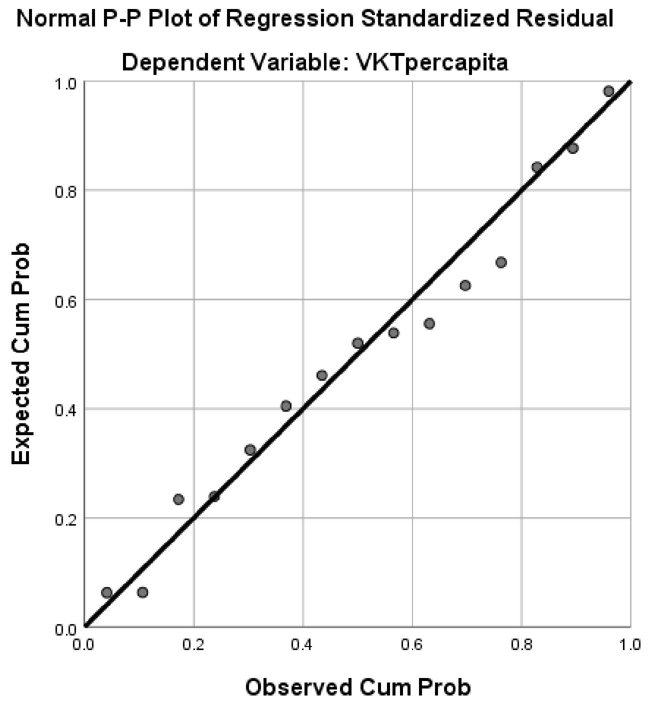
Residuals Statistics[a]

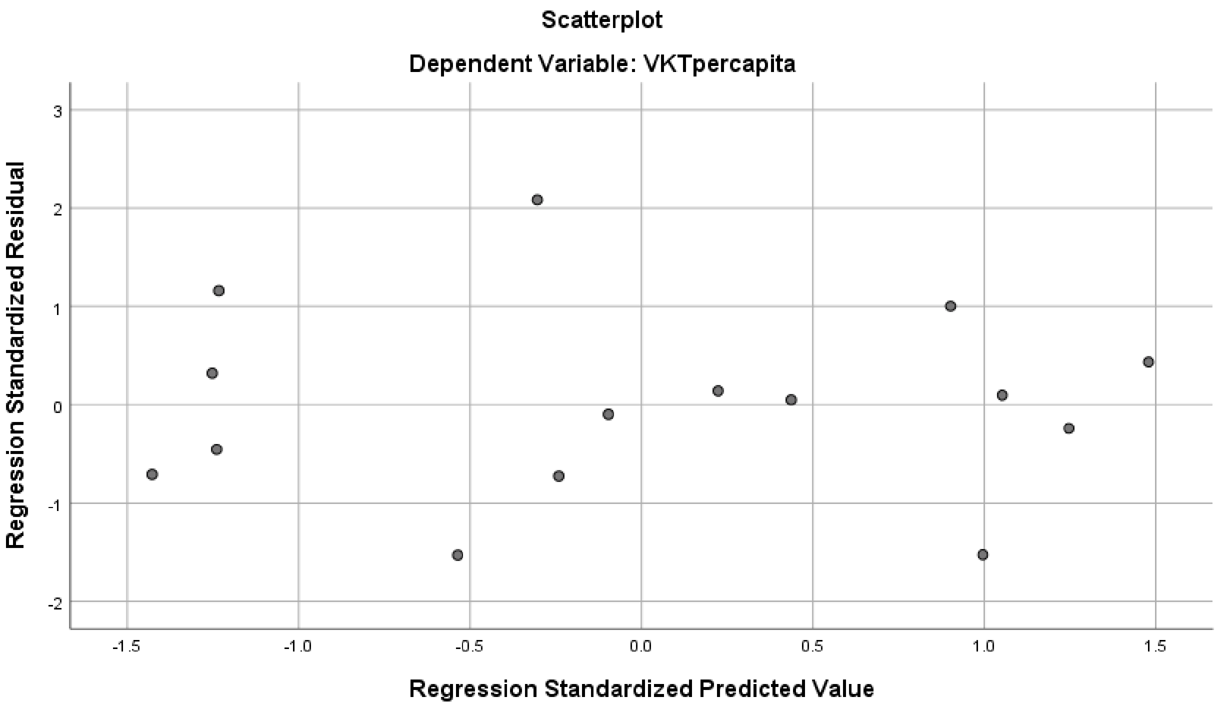
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	9172.4678	9668.4404	9416.1333	170.64755	15
Residual	-227.58020	309.78485	.00000	143.21750	15
Std. Predicted Value	-1.428	1.479	.000	1.000	15
Std. Residual	-1.531	2.084	.000	.964	15

a. Dependent Variable: VKTpercapita

Charts




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: VKTpercapita
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: VKTpercapita
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
-1
-2
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5

Appendix H

Petrol price versus unemployment rate – raw results

Regression

Notes

Output Created		15-APR-2018 19:07:18
Comments		
Input	Data	C:\Users\rshei\OneDrive\Documents\Masters Dissertation\Masters Data.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	15
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.

Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT VKTpercapita /METHOD=ENTER Petrolretailprice Unemploymentrate /SCATTERPLOT=(*ZRESID ,*ZPRED) /RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).
Resources	Processor Time	00:00:01.41
	Elapsed Time	00:00:01.35
	Memory Required	3152 bytes
	Additional Memory Required for Residual Plots	664 bytes

Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9399.3333	243.12561	12
Petrolretailprice	175.1608	31.29200	12
Unemploymentrate	5.0117	1.06162	12

Correlations

		VKTpercapita	Petrolretailprice	Unemploymentrate
Pearson Correlation	VKTpercapita	1.000	-.922	-.916
	Petrolretailprice	-.922	1.000	.726
	Unemploymentrate	-.916	.726	1.000
Sig. (1-tailed)	VKTpercapita	.	.000	.000
	Petrolretailprice	.000	.	.004
	Unemploymentrate	.000	.004	.
N	VKTpercapita	12	12	12

	Petrolretailprice	12	12	12
	Unemploymentrate	12	12	12

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Unemploymentrate, Petrolretailprice[b]	.	Enter

a. Dependent Variable: VKTpercapita

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.989[a]	.979	.974	38.98000

a. Predictors: (Constant), Unemploymentrate, Petrolretailprice

b. Dependent Variable: VKTpercapita

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10737.842	67.684		158.646	.000
	Petrolretailprice	-4.230	.546	-.544	-7.747	.000
	Unemploymentrate	-119.249	16.093	-.521	-7.410	.000

Coefficients[a]

Model		95.0% Confidence Interval for B	
		Lower Bound	Upper Bound
1	(Constant)	10584.730	10890.954
	Petrolretailprice	-5.465	-2.995
	Unemploymentrate	-155.655	-82.844

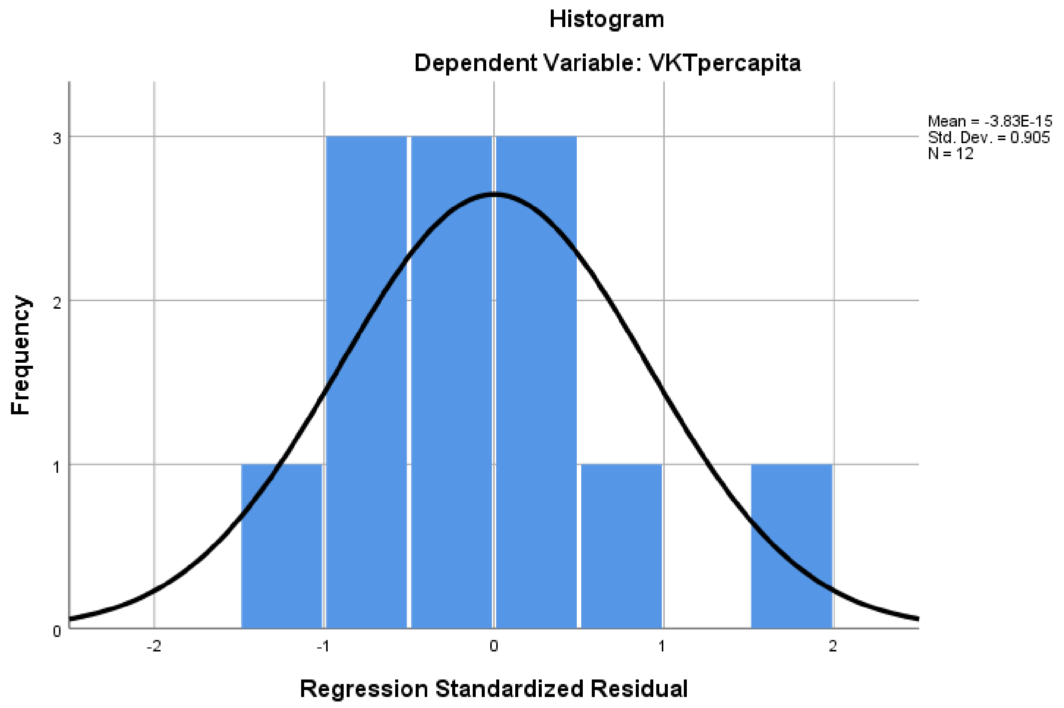
a. Dependent Variable: VKTpercapita

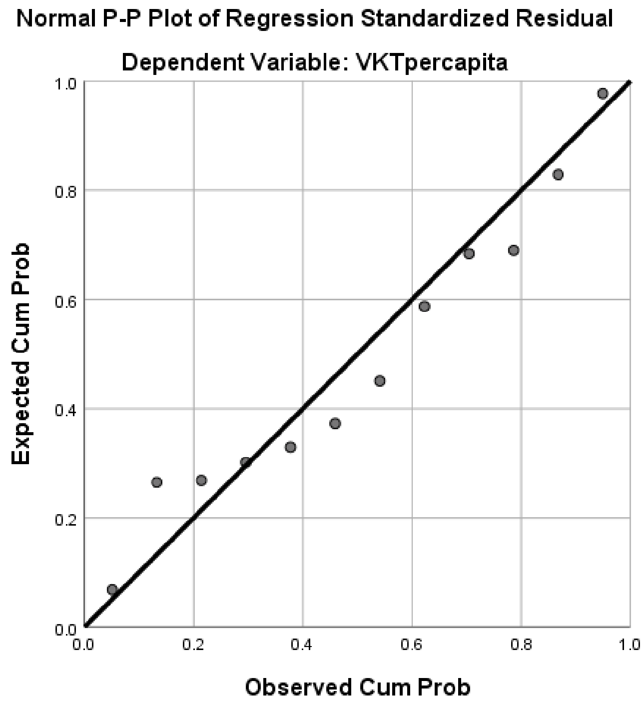
Residuals Statistics[a]

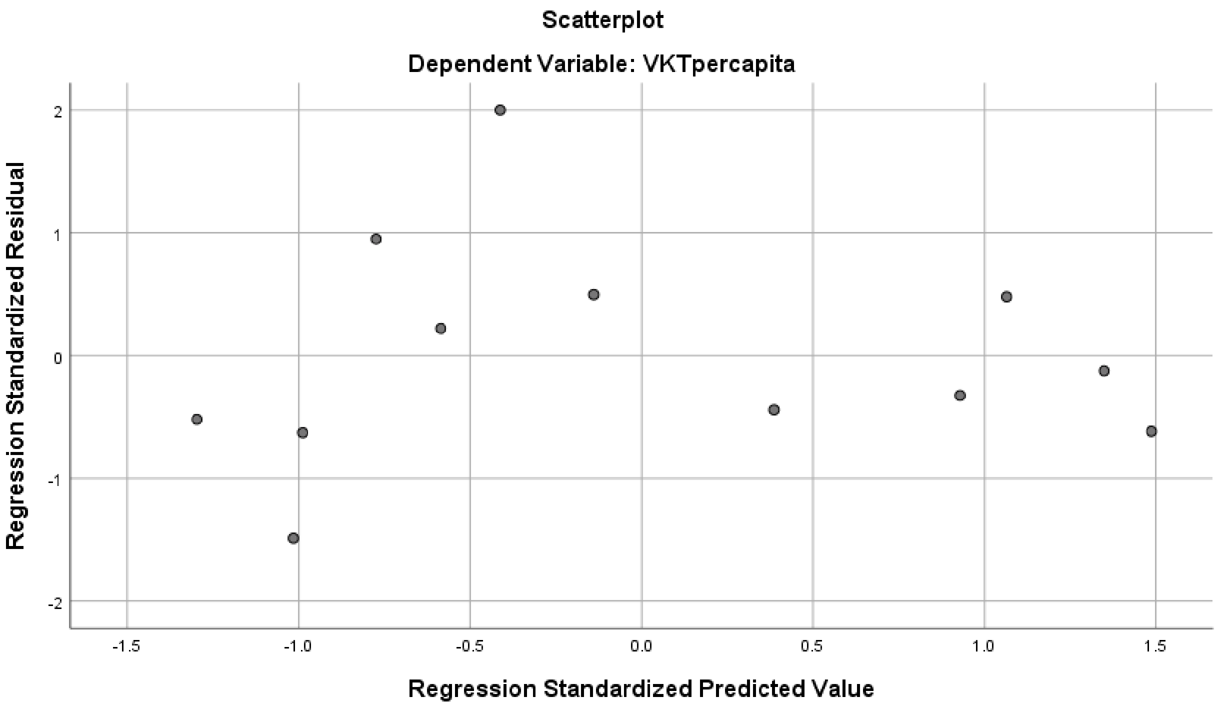
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	9087.2559	9757.0420	9399.3333	240.55536	12
Residual	-58.03650	77.94472	.00000	35.25874	12
Std. Predicted Value	-1.297	1.487	.000	1.000	12
Std. Residual	-1.489	2.000	.000	.905	12

a. Dependent Variable: VKTpercapita

Charts




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: VKTpercapita
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: VKTpercapita
Regression Standardized Residual
Regression Standardized Predicted Value
2
1
0
-1
-2
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5

Appendix I

Petrol price versus building consents – raw results

Regression

Notes

Output Created		15-APR-2018 18:56:51
Comments		
Input	Data	C:\Users\rshei\OneDrive\Documents\Masters Dissertation\Masters Data.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	15
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.

Syntax		REGRESSION /DESCRIPTIVES MEAN STDDEV CORR SIG N /MISSING LISTWISE /STATISTICS COEFF OUTS CI(95) R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT VKTpercapita /METHOD=ENTER Petrolretailprice Buildingconsents /SCATTERPLOT=(*ZRESID ,*ZPRED) /RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).
Resources	Processor Time	00:00:01.72
	Elapsed Time	00:00:01.34
	Memory Required	3152 bytes
	Additional Memory Required for Residual Plots	664 bytes

Descriptive Statistics

	Mean	Std. Deviation	N
VKTpercapita	9399.3333	243.12561	12
Petrolretailprice	175.1608	31.29200	12
Buildingconsents	21766.7500	5824.45361	12

Correlations

		VKTpercapita	Petrolretailprice	Buildingconsents
Pearson Correlation	VKTpercapita	1.000	-.922	.694
	Petrolretailprice	-.922	1.000	-.534
	Buildingconsents	.694	-.534	1.000
Sig. (1-tailed)	VKTpercapita	.	.000	.006
	Petrolretailprice	.000	.	.037
	Buildingconsents	.006	.037	.
N	VKTpercapita	12	12	12

	Petrolretailprice	12	12	12
	Buildingconsents	12	12	12

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Buildingconsents , Petrolretailprice[b]	.	Enter

a. Dependent Variable: VKTpercapita

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.953[a]	.908	.887	81.74615

a. Predictors: (Constant), Buildingconsents, Petrolretailprice

b. Dependent Variable: VKTpercapita

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10193.308	240.940		42.306	.000
	Petrolretailprice	-5.996	.932	-.772	-6.435	.000
	Buildingconsents	.012	.005	.282	2.352	.043

Coefficients[a]

Model		95.0% Confidence Interval for B	
		Lower Bound	Upper Bound
1	(Constant)	9648.263	10738.353
	Petrolretailprice	-8.103	-3.888
	Buildingconsents	.000	.023

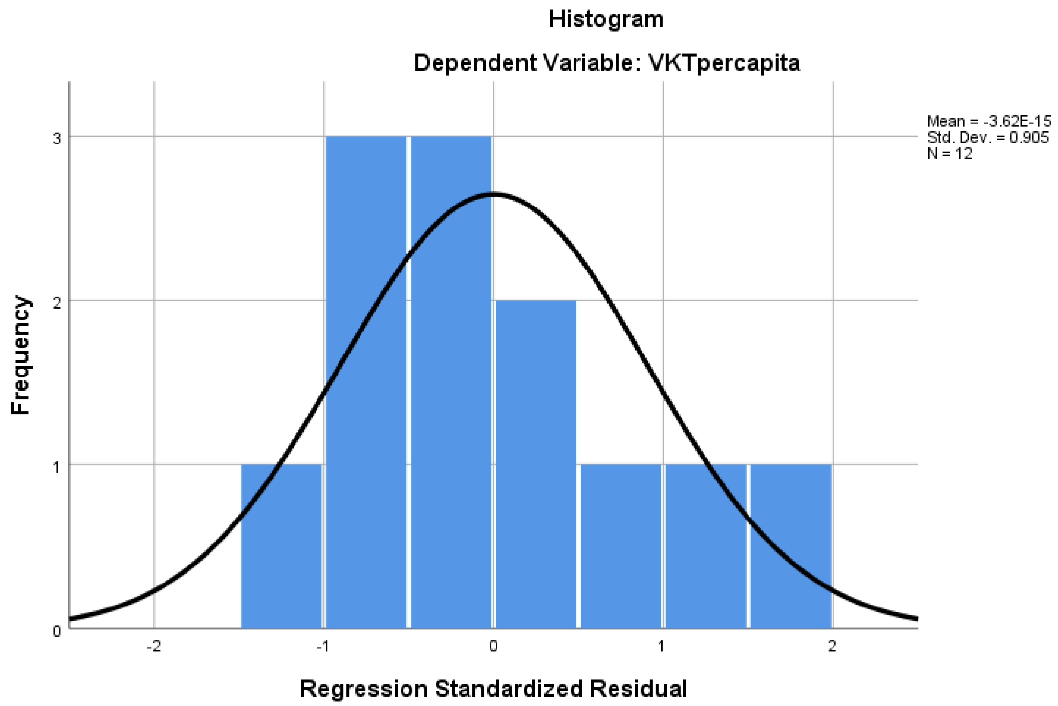
a. Dependent Variable: VKTpercapita

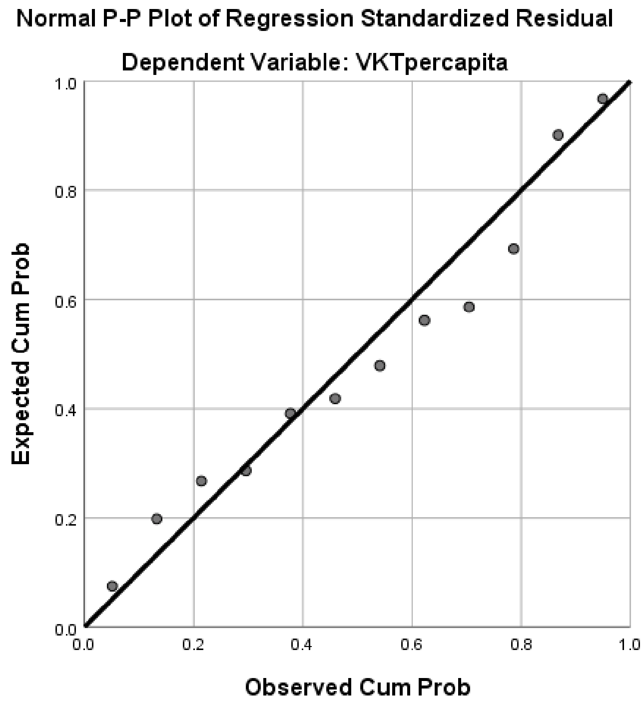
Residuals Statistics[a]

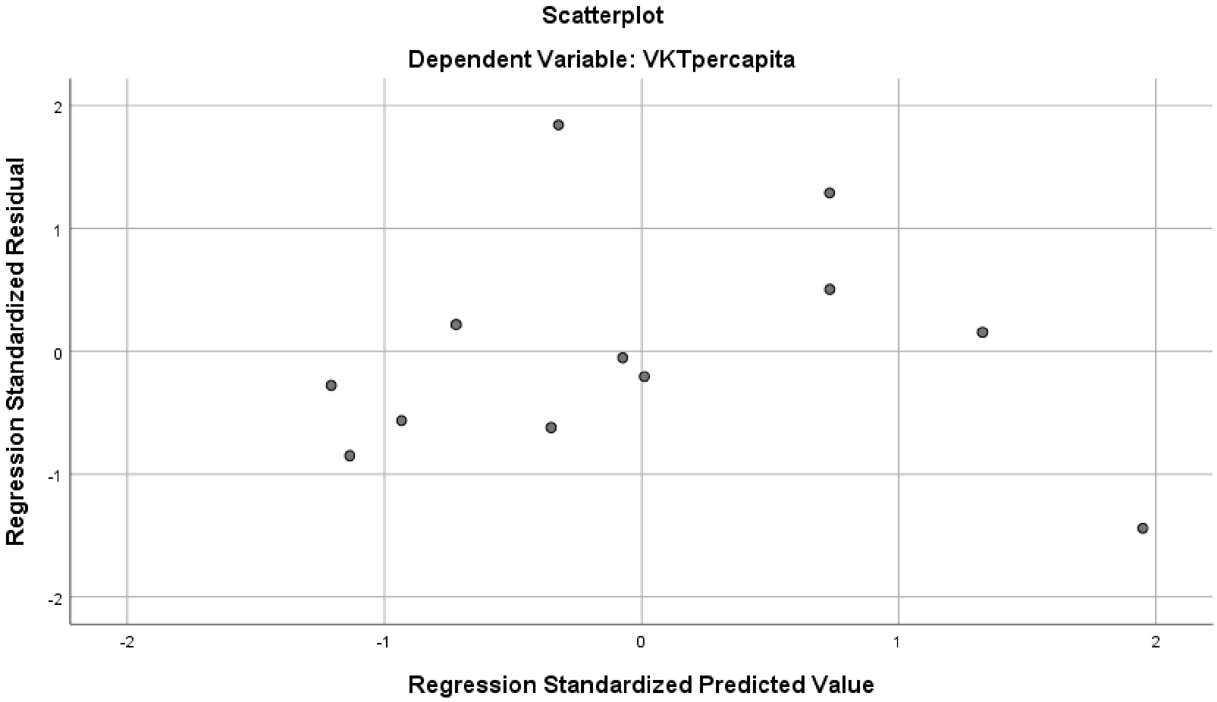
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	9119.6221	9850.7480	9399.3333	231.60875	12
Residual	-117.74796	150.60960	.00000	73.94218	12
Std. Predicted Value	-1.208	1.949	.000	1.000	12
Std. Residual	-1.440	1.842	.000	.905	12

a. Dependent Variable: VKTpercapita

Charts




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: VKTpercapita
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: VKTpercapita
Regression Standardized Residual
Regression Standardized Predicted Value
-2
-1
0
1
2

References

Bastian, A. & Borjesson, M. (2015). Peak car? Drivers of the recent decline in Swedish car use. *Transport Policy*, 42, 94-102

Bastian, A., Borjesson, M., & Eliasson, J. (2016). Explaining ‘‘peak car” with economic variables. *Transportation Research Part A*, 88, 236-250

BITRE. (2012). Traffic Growth: Modelling a Global Phenomenon (Report No. 128). Canberra, Australia: Department of Infrastructure and Transport

Curran, M. (2014). Peak car: Does it exist and is it evident in New Zealand? Wellington, New Zealand: Ministry of Transport.

Goodwin, P. (2012). Peak Travel, Peak Car and the Future of Mobility: Evidence, Unresolved Issues, Policy Implications, and a Research Agenda. Paper presented at the International Transport Forum, Paris, France

Goodwin, P. & Van Dender, K. (2013). ‘Peak Car’ - Themes and Issues. *Transport Reviews*, 33 (3), 243-254

Headicar, P. (2013). The Changing Spatial Distribution of the Population in England: Its Nature and Significance for ‘Peak Car’. *Transport Reviews*, 33(3), 310-324

Hjorthol, R. (2016). Decreasing popularity of the car? Changes in driving licence and access to a car among young adults over a 25-year period in Norway. *Journal of Transport Geography*, 51, 140-146

Huo, H., Zhang, Q., He, K., Yao, Z., & Wang, M. (2012). Vehicle-use intensity in China: Current status and future trend. *Energy Policy*, 43, 6-16

Kenworthy, J. (2013). Decoupling Urban Car Use and Metropolitan GDP Growth. *World Transport Policy and Practice*, 19(4), 7-21

Kuhnimhof, T., Buehler, R., Wirtz, M., & Kalinowska, D. (2012). Travel trends among young adults in Germany: increasing multimodality and declining car use for men. *Journal of Transport Geography*, 24, 443-450

Kuhnimhof, T., Zumkeller, D., & Chlond, B. (2012). Who Are the Drivers of Peak Car Use? A Decomposition of Recent Car Travel Trends for Six Industrialized Countries. *Transportation Research Record: Journal of the Transportation Research Board*, 2383.

Kuhnimhof, T., Zumkeller, D., & Chlond, B. (2013). Who Made Peak Car, and How? A Breakdown of Trends over Four Decades in Four Countries. *Transport Reviews*, 33, 325-342

MBIE. (2017). Weekly fuel price monitoring. Retrieved from http://www.mbie.govt.nz/info-services/sectors-industries/energy/liquid-fuel-market/weekly-fuel-price-monitoring

McSaveney, J. & Sage, I. (2014). New Zealand transport and society: Trends and projections. Wellington, New Zealand: Ministry of Transport.

Metz, D. (2013). Peak Car and Beyond: The Fourth Era of Travel. *Transport Reviews*, 33, 255-270

Metz, D. (2015). Peak Car in the Big City: Reducing London's transport greenhouse gas emissions. *Case Studies on Transport Policy*, 3, 367-371

Ministry of Transport. (2017a). New Zealand Vehicle Fleet Statistics. Retrieved from http://www.transport.govt.nz/research/newzealandvehiclefleetstatistics/

Ministry of Transport. (2017b). Government Policy Statement on Land Transport. Wellington, New Zealand: New Zealand Government

Ministry of Transport. (2017c). Transport volume: Vehicle travel. Retrieved from http://www.transport.govt.nz/ourwork/tmif/transport-volume/tv003/

Newman, P. & Kenworthy, J. (2011). 'Peak Car Use': Understanding the Demise of Automobile Dependence. *World Transport Policy and Practice*, 17(2), 31-45

Nishimura, E. (2011). Assessing the Fuel Use and Greenhouse Gas Emissions of Future Light-Duty Vehicles in Japan (Masters Dissertation, Massachusetts Institute of Technology)

Puentes, R. (2012). Have Americans Hit Peak Travel? A Discussion of the Changes in US Driving Habits. Paper presented at the International Transport Forum, Paris, France

Van Dender, K. & Clever, M. (2013). Recent trends in car usage in advanced economies: Slower growth ahead?; summary and conclusions. Paper presented at the International Transport Forum, Paris, France

Van Wee, B. (2015). Peak car: The first signs of a shift towards ICT-based activities replacing travel? A discussion paper. *Transport Policy*, 42, 1-3

World Bank. (2017). World Bank Open Data. Retrieved from http://data.worldbank.org/